Quincy –Oroville Road
CA-PFH 119-1(3)

Plumas National Forest, Plumas County, California

FINAL PAVEMENT DESIGN REPORT

January 16, 2007

Report by:
Yeh and Associates
5700 East Evans Avenue
Denver, Colorado 80222
Project No. 25-193

Prepared for:
Washington Group International
7800 East Union Avenue, Suite 100
Denver, Colorado 80237

Federal Highway Administration
Central Federal Lands Highway Division
Lakewood, Colorado

Distribution:
FHWA (5)
Washington Group (1)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

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Prepared by:

Robert F. LaForce, P.E.
Senior Materials Manager

Reviewed by:

Shan Tai Yeh, P.E.
President

1.0 INTRODUCTION

This route starts at the east end of California SR-162 east of Oroville and proceeds easterly 20.05 miles over Butte County Road CR-27561, 13.38 miles over Plumas County Road CR-414, 9.5 miles over Plumas County Road CR-423, 2.67 miles over Plumas County Road CR-414, and 6.35 miles over Plumas County Road CR-411 to the intersection with California SR-70 in Quincy for a total route length of 51.95 miles.

The CR-27561 portion is owned and maintained by Butte County and CRs-414, 423, 422, and 411 by Plumas County. The route is functionally classified as a major collector, except for CR-423, which is a local road serving Plumas National Forest. According to Forest Service data, 75% of the traffic is forest related and the principal Forest Service resources served are recreation, mining, and timber. The route also serves other local needs including school buses, mail delivery, commercial supply, and access to private property within the forest. The route serves one Forest Service owned campground and the recreation area at Bucks Lake. It also serves as a detour for traffic on SR-70 when there is flooding in the Feather River Canyon.

The proposed CA PFH 119-1(3) project limits include four different sections along this route that are all located in Plumas County. The following describes the project limits from west to east:

* Section one is a 4.6-mile portion of CR-414 (a.k.a. Bucks Lake Road) between the FH 119-1(1) reconstruction project completed in 1989 near the top of Frenchman Hill grade to Bucks Lake Road (Haskins Tee) intersection just south of Bucks Lake. This corresponds to County milepost (MP) 9.6 to MP 14.1. A bridge replacement at Grizzly Creek is also included in this segment.

* Section two is 1.0 mile in length on Big Creek Road (CR-423) from MP 0.0 at Bucks Lake Road (Haskins Tee) intersection east to MP 1.0.

* Section three is 2.8 miles in length on Big Creek Road from MP 3.2 to 6.0.

* Section four is 0.9 miles in length on Big Creek Road from MP 7.6 to MP 8.5.

The total length of roadway improvements on this project is 9.8 miles. The County repaired 2.2 miles (MP 1.0 – MP 3.2) of Big Creek Road in 2000 using State Transportation Improvement Program (STIP) funding.

The proposed construction is a 3R type project intended as recycling and overlay of surface with spot drainage improvements and a bridge replacement at the Grizzly Creek location. The proposed project is programmed in the Federal Lands Highway, Forest Highway program for obligation in FY 2010.

1.1 Climate

There is a weather station in Quincy, California located approximately seven miles east of the project. The elevation at Quincy is 3,432 feet above seal level. Table 1 shows the monthly average rainfall and high and low temperatures at Quincy. Bucks Lake is approximately 10 miles west of Quincy near the center of the project with an elevation of 5158 feet above seal level. The project location receives more rain and snow than Quincy. A portion of CR-423 is closed in the winter and is used as a snow mobile access. Snow mobile parking is located near the east end of this project where the road is closed during winter.

Table 1 – Climate and Weather History

	Average Maximum Temperature, °F	Average Minimum Temperature, °F	Average Precipitation Inches
January	47	24	6.77
February	53	27	6.75
March	59	29	5.59
April	65	31	2.53
May	75	37	1.53
June	83	42	0.71
July	91	44	0.24
August	90	42	0.27
September	84	38	0.84
October	73	31	2.55
November	56	28	4.90
December	47	24	5.64
Average/Total	68.6	33.1	38.3

In general, the majority of the pavement in the west portions of the project appears to be in fair to good condition because of what appears to be excellent maintenance. Much of the east two portions of this project area are in fair to poor condition. The purpose of this report is to investigate the subsurface conditions and existing pavement conditions and to provide preliminary geotechnical evaluation of the subgrade and pavement design recommendations based on twenty-year traffic loadings.

2.0 INVESTIGATION

2.1 Existing Pavement Condition

A project visit was conducted on July 18 and 19, 2006, to evaluate the current pavement condition, and facilitate other field sampling needed for this project.

This section of Quincy - Oroville Road is a two-lane facility with a width of 22 to 24 feet in most locations. Major widening is not anticipated under this project except in the area of Grizzly Creek where the bridge is to be replaced and the alignment is to be moved to the north of the present roadway.

The majority of the pavement in the west portion of this project is in fair to good condition, with isolated locations having distresses varying from severe fatigue cracking to minor/moderate rutting. The pavement in the east two sections of this project is in fair to poor condition. Table 2 contains an overview of each pavement sections' condition and Appendix A contains a photographic survey with pavement condition photographs related to project mileposts. Isolated locations with severe distresses are noted in the photographic survey in Appendix A and will be addressed later in this report.

Table 2 – Pavement Condition Survey

Location (Project Mile Posts)	Condition Description
MP 0.0 to 2.55	Surface texture is a good chip seal coat. Some edge cracking with isolated patches at edge with some full width patches. A few thermal transverse cracks of low to moderate severity.
MP 2.55 to 5.1+	Surface is older chip seal coat, more snowplow damage. Some low severity block and transverse cracking with isolated locations of severe thermal and fatigue cracking (MP 2.8, 50-75') or isolated locations of severe fatigue cracking apparently from soft subgrade (MP 3.5 +/- 3.7) Minor rutting, <1/2 inch (MP 4.1 to 5.0)
MP 5.1+ to 5.6	Roadway in good condition
M P 7.9 to 10.7	Severe shoving in top mat apparently from logging trucks on numerous turns. Isolated locations of moderate to severe block cracking (MP 8.1+) and severe fatigue cracking at suspected soft/saturated subgrade (MP 8.8) Subgrade settlement areas. (MP 10.1 and 10.4)
MP 11.9 to 13.0	Isolated low to moderate severity block and transverse cracking masked by good chip seal coat. Patching and moderate to severe transverse cracking near slide area (MP 11.9 to 12.0+)
MP 5.6 to 7.9*	Minor rutting
MP 10.8 to 11.9*	Shoving and raveling of top mat from logging trucks. Intermittent one-half inch ruts and isolated moderate to severe transverse cracking (MP 11.8)

* Mile Posts are outside of project area

2.2 Pavement and Base Thickness

The existing pavement and base course thickness was measured every quarter mile in either the eastbound or westbound lane during the sampling of subgrade and pavement. Table 3 lists the pavement and base thickness measurements taken at each location. Additionally, Appendix B contains bar graphs of pavement and base thickness measurements versus station to allow for quick determination of variation in depths along the project.

As can be seen in Table 3, the asphalt pavement thickness varies from 2.75 inches to 5.5 inches with an average of 3.96 inches in the west sections, and 3.82 in the east sections. The aggregate base course thickness was between 3.75 to 6.5 inches with an average thickness of 5.28 inches in the west sections, and 5.47 in the east sections.

3.0 SUBGRADE CONDITIONS

3.1 Subgrade Soils

Soil samples from borings taken approximately every one-half mile were tested to determine the AASHTO Soil Classification and gradation. After reviewing the various soil classifications, four R-values were measured in accordance with AASHTO T190. Boring #1 at Mile Post 0.0, tested as an A-5(0), considered the poorest soil sampled. Test Pit #1 at Mile Post 0.25 had an R-value of 19 and was classified as an A-2-6(0) soil. Test Pit #4 contained soil with AASHTO Classification A-1-a(0), considered the best soil sampled, and that sample had an R-value of 81.

Ten sample locations had soils with a classification of A-2-4(0). Several of these bulk samples were combined and had an R-value of 62. Five sample locations had soils with a classification of A-4(0). Several of these samples were combined and the R-value was 36 when tested in accordance with AASHTO T190. Table 4 is a summary of soil test results and Appendix C contains complete test results for each sample. Appendix D contains the boring logs and Engineering Geology sheets for this project. Groundwater was not encountered in any of the pavement borings.

Table 3 – Pavement and Base Thickness Measurements

Station 10+00 to 304+50
(Mile Posts 0.0 to 5.6)

Approx. Station	Hole No./ Direction	Pavement Thickness (inches)	Base Thickness (inches)
10	1 - EB	4.00	5.75
23	1a - EB	3.50	5.25
62.8	2 - EB	3.50	5.75
63.3	20a - WB	3.75	6.00
73	2a - EB	2.75	5.25
77	20 - WB	3.00	5.50
115.6	3 - EB	3.50	5.00
116.1	19a - WB	2.75	4.75
129	19 - WB	3.00	4.75
131	3a - EB	4.75	4.50
168	4 - EB	4.25	5.50
169	18a - WB	3.75	5.25
182	4a - EB	5.00	4.75
182	18 - WB	4.00	5.50
222	5 - EB	3.75	6.00
224	17a - WB	3.00	5.75
234	5a - EB	4.75	6.50
235	17 - WB	4.00	5.00
261	16a - WB	4.25	6.00
272	16 - WB	4.50	5.75
279	6 - EB	4.25	5.00
287	6a - EB	3.75	5.25
		Pavement	Base
Average Depth =		3.81	5.40

Test Pit Locations

Test Pit Number	Approx. Station	Pavement Thickness (inches)	Base Thickness (inches)
TP #1-EB	63	3.5	5.75
TP #2-EB	234	4.75	6.5
TP #3-EB	438	3.75	5.75
TP #4-EB	646	3.75	4.5
TP #5-WB	475	4	5

Station 426+79 to 574+70 and
Station 640+17 to 699+61
(Mile Posts 7.9 to 10.7 and 11.9 to 13.1)

Approx. Station	Hole No./ Direction	Pavement Thickness (inches)	Base Thickness (inches)
438	7a - EB	3.75	5.75
448	8 - EB	3.25	6.00
467	15a - WB	3.75	5.00
472	8a - EB	4.50	5.50
480	15 - WB	3.50	5.75
507	14a - WB	4.50	4.25
512	9 - EB	4.00	6.50
520	14 - WB	4.25	6.00
525	9a - EB	3.75	4.00
546	13a - WB	4.00	3.00
556	10 - EB	4.00	5.00
560	13 - WB	4.00	3.75
646	11a - EB	3.75	4.50
686	12a - WB	4.00	4.25
699	12 - WB	3.50	5.00
		Pavement	Base
Average Depth =		3.90	4.95

Sections Outside of Project Area

Approx. Station	Hole No./ Direction	Pavement Thickness (inches)	Base Thickness (inches)
327	22 - EB	4	No data
369	23 - EB	4.25	5.5
422	7 - EB	5	4.5
595	11 - EB	3.5	4.75
596	24 - EB	5.5	4.5
		Pavement	Base
Average Depth =		4.45	4.81
* Not Within Project Limits			

Table 4 - Summary of Laboratory Test Results

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 25 - 193 Project Name: Quincy - Oroville Road, Ca. Date: 9/28/2006

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	% Swell (+) / Consolidation (-)	Resistivity Ohm/cm	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI						AASHTO	USCS
# 1	5	Bulk	12.2	–	26	37	37	41	31	10	–	–	–	–	–	A - 5 (0)	SM
# 2	5	Bulk	6.8	–	40	33	27	NV	NP	NP	–	–	–	–	–	A-2-4 (0)	GM
# 3	5	Bulk	6.8	–	30	36	34	NV	NP	NP	6.2	0.000	–	13900	62*	A-2-4 (0)	SM
# 4	5	Bulk	17.6	–	28	40	32	43	39	4	5.9	0.003	–	–	–	A-2-5 (0)	SM
# 5	5	Bulk	9.1	–	21	41	38	30	25	5	–	–	–	–	36**	A - 4 (0)	SM
# 6	5	Bulk	11.5	–	19	41	40	31	28	3	–	–	–	–	36**	A - 4 (0)	SM
# 7	5	Bulk	5.5	–	21	48	31	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM
# 8	5	Bulk	11.1	–	18	68	14	NV	NP	NP	–	–	–	–	–	A-2-4 (0)	SM
# 9	5	Bulk	8.0	–	13	49	38	NV	NP	NP	–	–	–	–	–	A - 4 (0)	SM
# 10	5	Bulk	3.3	–	9	49	42	32	27	5	–	–	–	9500	36**	A - 4 (0)	SM
# 11	5	Bulk	5.4	–	40	36	24	31	25	6	–	–	–	–	–	A-1-b (0)	GM
# 12	5	Bulk	4.0	–	43	36	21	32	23	9	–	–	–	–	–	A-2-4 (0)	GC
# 13	5	Bulk	3.2	–	33	38	29	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM
# 14	5	Bulk	4.2	–	21	60	19	NV	NP	NP	–	–	–	–	–	A-1-b (0)	SM
# 15	5	Bulk	7.9	–	10	66	24	NV	NP	NP	–	–	–	–	–	A-1-b (0)	SM
# 16	5	Bulk	5.5	–	14	54	32	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM

* Combined Samples 3, 7, 13, 16, 19, and 24
** Combined Samples 5, 6, 10, and 20

Rev 2 - 8/02

Page 1 of 1

Table 4 - Summary of Laboratory Test Results - continued

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 25 - 193 Project Name: Quincy - Oroville Road, Ca. Date: 9/28/2006

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	% Swell (+) / Consoli-dation (-)	Unconf. Comp. Strength (psf)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI						AASHTO	USCS
# 17	5	Bulk	7.9	–	19	35	46	31	22	9	–	–	–	–	–	A - 4 (1)	SC
# 18	5	Bulk	5.1	–	16	65	20	NV	NP	NP	–	–	–	–	–	A-2-4 (0)	SM
# 19	5	Bulk	3.6	–	25	43	32	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM
# 20	5	Bulk	6.7	–	16	42	42	28	20	8	–	–	–	–	36**	A - 4 (0)	SC
# 22	5	Bulk	7.3	–	14	50	36,	NV	NP	NP	–	–	–	–	–	A - 4 (0)	SM
# 24	5	Bulk	2.2	–	22	49	29	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM
TP- 1	5	Bulk	8.1	–	50	34	16	33	22	11	–	–	–	–	19	A-2-6 (0)	GC
TP- 2	5	Bulk	3.5	–	46	44	10	NV	NP	NP	–	–	–	–	–	A-1-a (0)	GW - GM
TP- 3	5	Bulk	8.7	–	53	36	11	NV	NP	NP	–	–	–	–	–	A-1-a (0)	GP - GM
TP- 4	5	Bulk	6.1	–	47	40	13	NV	NP	NP	–	–	–	–	81	A-1-a (0)	GM
TP- 5	5	Bulk	4.3	–	43	49	8	NV	NP	NP	–	–	–	–	–	A-1-a (0)	SW - SM

* Combined Samples 3, 7, 13, 16, 19, and 24
** Combined Samples 5, 6, 10, and 20

Rev 2 - 8/02

Page 1 of 1

4.0 PAVEMENT DESIGN AND RECOMMENDATIONS

4.1 Traffic Loading

The section of the Quincy to Oroville Road being addressed by this project is closed at least four months each winter and may receive eight feet or more of snow. During the time the roadway is open to traffic, it receives relatively heavy use as a recreation and logging route. The travel speed on most of this route is approximately 25 miles per hour (mph), although the new Grizzly Creek Bridge alignment will allow for a speed of 40 mph.

Construction on this project is scheduled for 2010. Year 1994 measured traffic and 2024 projected traffic information was provided. This traffic information appears on the cover sheet of the 30% plans dated October 2006. Using this information, year 2010 and 2030 traffic loadings were calculated by determining the annual growth factor from the traffic information provided and then using that growth factor to calculate future volumes. The 20-year Equivalent Single Axle Loads (ESALs) were then calculated by averaging the projected (2010) and twenty-year (2030) volumes to get a single design volume. The percentage of each vehicle type was then combined with the individual vehicle type ESAL factor to calculate the total loading for a 20-year period. A lane correction factor for a two-lane roadway was applied to each section to determine design ESALs. This pavement design might be checked against more current traffic loadings if it becomes available.

Using this method, design ESALs were calculated for two sections of this project. West of Haskins Tee (Station 0+00 to 253+00) the design 20-year ESALs were 1,125,661 and East of Haskins Tee (Station 253+00 to 699+61), 20-year ESALs of 1,207,142 ESALs was used. These large Design ESALs are a result of the relatively high number of logging trucks in this area.

Appendix E shows the method and all calculations used to determine the 20-Year ESAL values used in the pavement design.

4.2 Subgrade Strength

In the project area there were no large continuous sections of roadway containing a single subgrade soil type. The ten A-2-4(0) and five A-4(0) soils occurred randomly in the subgrade throughout the length of the project. As noted above, the combined A-2-4(0) samples had an R-value of 62, and the combined A-4(0) samples had an R-value of 36. Using these values, a weighted average R-value of 53 was calculated, however, because the previous two projects on the Quincy-Oroville Road experienced failures either during or within one year of construction a lower R-value of 35 was used to represent the subgrade strength for the pavement designs. In addition to the lower R-value, the reliability was raised from 75 to 80% to help insure that this project does not experience the same type of base or shoving failures as the previous projects. Logging trucks braking to make turns are believed to be causing the shoving failures as pictured on page 10.

The following equations are from the Colorado Department of Transportation (CDOT) Pavement Design Manual, but they originally came from NCHRP Study 128, which was used in the AASHTO 1993 Pavement Design Guide. Using these equations, an R-value of 35 was used to calculate a resilient modulus of 8,065 psi.

$S_1 = [(R-5)/11.29] + 3$ (Eq. 2.1)

$M_R = 10^{[S_1 + 18.72)/6.24]}$ (Eq. 2.2)

Where: M_R = resilient modulus (psi)
S_1 = the soil support value
R = the R-value obtained from the Hveem Stabilometer (AASHTO T190)

The resilient modulus of 8,065 was then used as one of the inputs for the DARWin Pavement Design computer program to determine recommended pavement thickness for this project. Both the CDOT Pavement Design Manual and the DARWin pavement design computer program follow the AASHTO 1993 Pavement Design Manual.

Other Structural Layer coefficients were assigned based on various treatments found in the "Guidelines for Completing the Pavement Investigation and Report (V1 and V2 Activities) CFLHD January 2005."

4.3 Rehabilitation Treatments

Pavement designs for numerous treatments were performed, and considered based on ease of construction and cost.

Mile Posts 0.0 to 5.6 (Station 0+00 to 306+47.91) - As noted earlier in the Pavement Condition section, the pavement between MP 0.0 and 5.6 is in fair to good condition. In this section, a conservative strength coefficient of 0.26 was assigned to the existing 3.5 inches of pavement, and a 4.0-inch overlay of the existing roadway is recommended to address the twenty-year design loadings. There are isolated "soft spots" that will need to be addressed. These locations will be discussed later in this report.

One idea presented to help prevent the shoving failures pictured below was to mill 1 +/- inch of the surface prior to overlay. If this treatment is chosen, the overlay thickness will need to be increased by 0.6 inches for each 1.0-inch of pavement removed.

In the reconstruction section at Grizzly Creek, we recommend that the top two feet of imported material be required to meet an R-value of 50, and that a composite pavement consisting of 6.0 inches of Aggregate Base Course (ABC) Class 6 and 5.0 inches of HCAP be used.

Mile Posts 7.9 to 10.7 (Station 426+79 to 574+70) -The existing pavement is in fair to poor condition, and many of turns contain shoving distresses in the top mat. The following Figure 1 shows an example of this distress along with low to moderate severity block cracking. This same distress was experienced at the interface of the new three-inch pavement on one to the earlier Quincy-Oroville Road projects.

Figure 1 – Shoving Distress from Logging Trucks

Because of the occurrence of this type of distress, the top mat is not considered to be well bonded to the lower layers, so the recommended option for this section would be to cold recycle the top 3.5 inches followed by a four-inch overlay using new HACP. The new HACP should be placed in two lifts.

Unfortunately, this distress also has occurred at several locations in the no work area between Mile Posts 10.7 and 11.9.

The remaining section from Mile Post 11.9 to 13.1 (Station 640+17 to 699+61) does not have any shoving distress, but has numerous locations with moderate to high severity linear cracking, so the 3.5 inches of cold recycle followed by a 4.0 inch overlay is also the recommended rehabilitation.

Complete pavement design calculations using the DARWin Pavement Design Program for the thickness of each alternate treatment appears in Appendix F, and the complete calculations for the cost of each treatment considered appears in Appendix G.

4.4 Discussion of Treatments

Mile Post 0.0 to 5.6 (Start of Project to one mile east of Haskins Tee)

Overlay of Existing - As mentioned above, the existing pavement is in fair to good condition, and with some full depth patching to address localized soft subgrade, the existing pavement should serve as an excellent base for a new Hot Asphalt Concrete Pavement (HACP) overlay. The localized patching locations will be addressed in a later section of this report.

If after discussions with local agency officials more familiar with the performance of pavements in this area, it is felt that the existing pavement will deteriorate badly between the present and the planned construction date of 2010, cold recycling 3.5 inches followed by a 4.0-inch HACP

overlay would be the preferred option. Further discussions of cold recycling and overlay are presented below.

Mile Post 7.9 to 10.7 and MP 11.9 to 13.1

Cold Recycle + Overlay - As discussed above we recommend that the existing pavement be cold recycled to a depth of 3.5 inches, and then receive a 4.0-inch overlay of new HACP. Most of the existing pavement from MP 7.9 to 10.7 is in poor condition and contains a questionable top asphalt mat. Cold recycling 3.5 inches will maximize the depth of cold recycling and address the top mat in questionable condition. The 3.5 inches of cold recycling will also help limit any reflective cracking through the new HACP in the thicker pavement sections.

Pulverization + Overlay - This treatment would also address the questionable top mat as well as the distresses in the eastern most section. The treatment would provide a relatively uniform subgrade for the new overlay. This treatment would require a 5.5-inch new HCAP pavement.

Full Depth Reclamation Options - These treatments, using any of the calculated options, foamed asphalt, asphalt emulsion, or cement, are more expensive than the cold recycle option. Full depth reclamation with cement requires a 4.5-inch overlay, while full depth reclamation with either foamed asphalt or emulsion would require 4.0 inches of HACP, the desired minimum thickness of new HACP for this project.

While this section of the Quincy to Oroville Highway is a narrow and winding road, there are no very sharp (hairpin) turns that would prevent the use of in-place cold recycling.

Table 5 – Recommended HACP Thickness and Treatment Cost Comparison

Treatment	HACP Overlay Thickness (in.)	Cost $/yd^2
Overlay Existing	4.0	$22.00
Cold Recycle + Overlay	4.0	$27.00
Pulverization 6" + Overlay	5.5	$34.25
FDR - Foamed Asphalt + Overlay	4.0	$30.31
FDR - Emulsion + Overlay	4.0	$30.40
FDR - Cement + Overlay	4.5	$29.92

* FDR = Full Depth Reclamation

4.5 Pavement Section for Grizzly Creek Realignment

A new pavement section was designed for the realigned approaches to the new Grizzly Creek Structure. For this design, the top two feet of fill material should be required to have a minimum R-value of 50, which was used to calculate a resilient modulus of 13168. Using this information, a composite section using aggregate base and new HACP was designed. The new section will require 6 inches of ABC, Class 6 having a minimum R-value $\geq$ 65 followed by 5 inches of new HACP.

The pavement design for the Grizzly Creek section also appears in Appendix G.

4.6 Localized Soft Spots

In addition to the maintenance patches near the east end of the project, seven localized soft spots were identified during the pavement review on July 18 and 19, 2006. These locations of failing pavement need to be deep patched prior to placement of the recommended 4.0-inch overlay.

The locations identified in the pavement survey are:
MP 0.9 - failing patch in the east bound lane
MP 2.8 - badly alligator cracked section 50 to 75 feet in length
MP 3.6 +/- - badly fatigued cracked section approximately 200 feet long
MP 4.5 - spot pavement failure location approximately 20-30 feet in length
MP 5.0 - west bound fatigued area
MP 8.1 - Fatigue-cracked section
MP 10.1 - Slump Failure in East Bound Lanes
The local agency maintenance personnel would be of help to identify other spot locations, which may need full depth patching.

Photographs of each of these sections appear in the Photographic Pavement Condition Section in Appendix A. The locations are listed by the same project mileposts as shown above.

These sections should be sub-excavated to a minimum depth of three feet, replaced and recompacted using a material meeting a minimum R-value of 50. A new pavement should then be placed conforming to the design for the new Grizzly Creek alignment, six inches of ABC and five inches of HACP.

5.0 BINDER AND MIX RECOMMENDATIONS

The performance graded binder recommended for this section is PG 64-28. From the Caltrans Climate/Region maps, this project is located in the High Mountain zone, where Caltrans grade selection criteria recommends a PG 64-28. The PG 64-28 binder will provide a 98% reliability binder for the entire project, and PG 64-28 is recommended.

An additional idea to address rutting was to use stiffer asphalt such as PG 70-28. At this time, Caltrans does not specify a PG 70-28. PG-70-10 grade is the stiffest asphalt listed in the current specifications. PG 70-10 would not be acceptable in this project area because using this binder would make the new overlay very susceptible to thermal transverse cracking. If a PG 70-28 becomes available, it should be considered for use on the new pavement in this project area.

The new HACP overlay should be a nominal ½-inch mix with the above recommended binder. Grading Designation E mix is recommended (as per FP-03). Caltrans has adopted the Superpave Mix Design system and a 75-gyration mix design using a ½ inch nominal mix is recommended.

If paving is done in cool weather, a material transfer device may be needed to obtain uniform temperatures of mix during placement.

The quantity of binder can be estimated at 6% by weight of the mix and the unit weight can be estimated at 145 lbs/ft^3.

Tack coat (at 0.10 gallons/ yd^2) is required on the cold recycled base material prior to paving. The tack coat material should be CSS-1, CSS-1h, SS-1, or SS-1h. A tack coat at the above rate should be included between each lift of HACP.

For the new alignment section at Grizzly Creek, the aggregate base course should receive a prime coat of an emulsion blended as a penetrating prime at a rate of 0.33 gallons/yd^2. Medium cure cutback asphalts, MC-70 for example, are not allowed in California because of VOC requirements. If an emulsion such as CSS-1 is used for prime coat, it should be disked into the top 2-3 inches of base course and re-compacted prior to placement to the new HACP.

If the cold recycle option is chosen, the emulsion used for cold recycle should be HFMS-2s, and the cold recycled pavement should have hydrated lime added to the cold recycle at a rate of 1% by weight of pavement, 3.9 pounds of lime per square yard of pavement, 3.5 inches thick. In addition to the inclusion of hydrated lime, the compacted cold recycled mat may need to be tack coated if raveling starts to occur. Many state specifications require that the cold recycled mat be tacked or covered with the bottom lift of HACP within ten days of placement.

6.0 LIMITATIONS

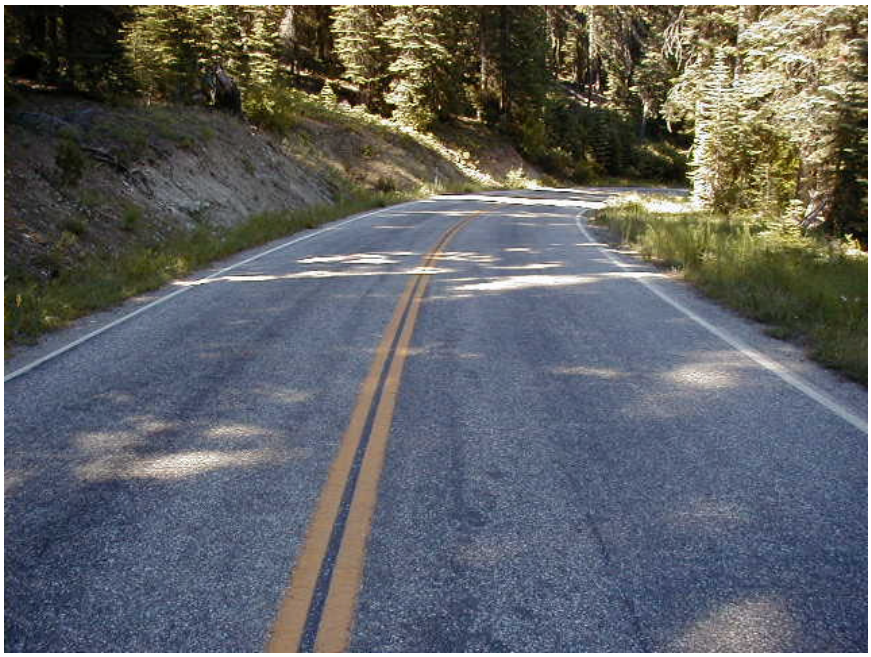
This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use in pavement design. The conclusions and recommendations submitted in this report are based upon the data obtained from exploratory borings, field reconnaissance, and the proposed type of construction. The nature and extend of subsurface variations across the site may not become evident until excavation is performed. If during construction, fill, soil, or water conditions appear to be different from those described herein, this office should be advised at once so re-evaluation of the recommendations may be made. We recommend on-site observation of excavations and foundation bearing strata by a representative of the geotechnical engineer.

APPENDIX A
Photographic Pavement Condition Survey

Appendix A

Pavement Condition Survey (8-18-06 & 8-19-06)
Section 1 – MP 0.0 to 5.6

MP 0.0 Looking East – Chip Seal on sound pavement



MP 0.2 Looking East – Sound Pavement

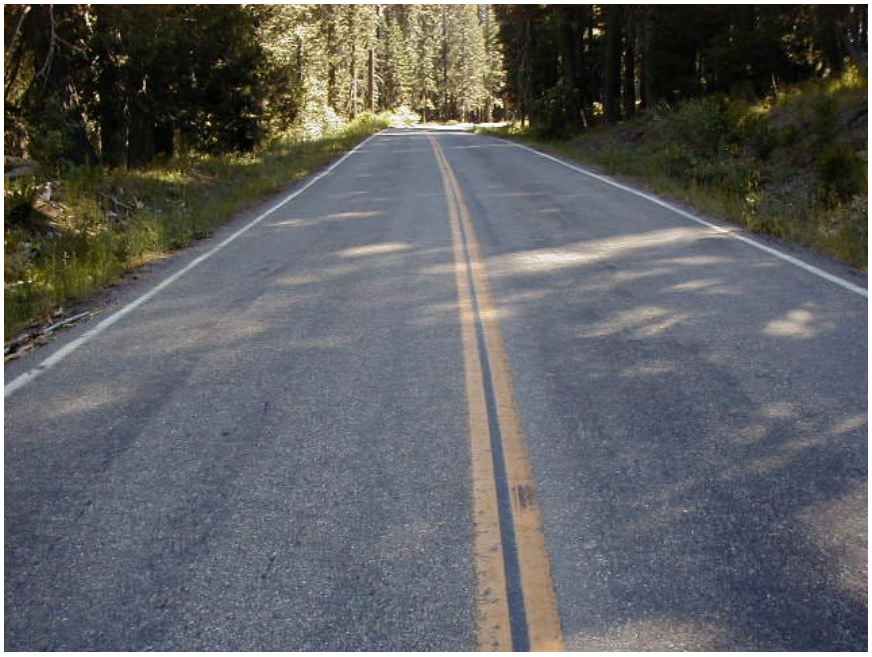
MP 0.4 Chip seal in good condition

MP 0.6 Patches on both sides of roadway West Bound Lane (WBL)

MP 0.6 Large patch in East Bound Lane (EBL)

MP 0.8 Sound pavement

MP 0.9 Base failure at shoulder in patch



MP 1.0 Sound Pavement

MP 1.1 Edge Cracking EBL

MP 1.4 Sound Pavement

MP 1.4 EBL Edge Cracking needs supporting shouldering material

MP 1.5 Edge Patch WBL, Moderate thermal crack EBL

(Realignment MP 1.54 to 1.80-, Grizzly Creek Bridge)

MP 1.8 Looking east – Sound Pavement

MP 2.2 Looking west – Sound Pavement

MP 2.55 Looking East - end chip seal coat

MP 2.6 Looking East – Sound Pavement

MP 2.6 Minor longitudinal cracking, damaged chip seal

MP 2.8 Thermal and Alligator Cracking

MP 2.8 Severe alligator crack in this location

MP 3.0 Damaged Chip Seal

MP 3.4 Bucklin Road

MP 3.6+ Rutting and Fatigue Cracking

MP 3.7 Severe Alligator Cracking – Soft Spot

MP 3.6+ Rutting and fatigue cracking in WBL

M P 3.7 Location of soft spot in WBL

MP 3.7+ EBL at soft spot

MP 3.8 Looking East – Sound Pavement

MP 4.0 Looking East - Sound Pavement

MP 4.1 Minor Rutting in WBL

MP 4.2 Looking toward Buck's Lake Road (east) – Sound Pavement

MP 4.5 Looking north to Buck's Lake Road – Severe Transverse Cracking

MP 4.5 Looking east from Buck's Lake Road

MP 4.85 Looking west minor rutting and low severity block cracking

MP 5.0 Rutting in WBL plus block and alligator cracking

MP 5.0 3/8-inch rut in left wheel path of WBL

MP 5.1 end machine patch

MP 5.1 Looking west - Minor block cracking WBL

MP 5.5 Looking west – Sound Pavement

MP 5.5 Begin new overlay

(No Work Section, MP 5.6 to 7.9)

MP 5.9 Start thin overlay – sound pavement

MP 6.5 sound pavement

MP 6.7 Looking East – Sound Pavement

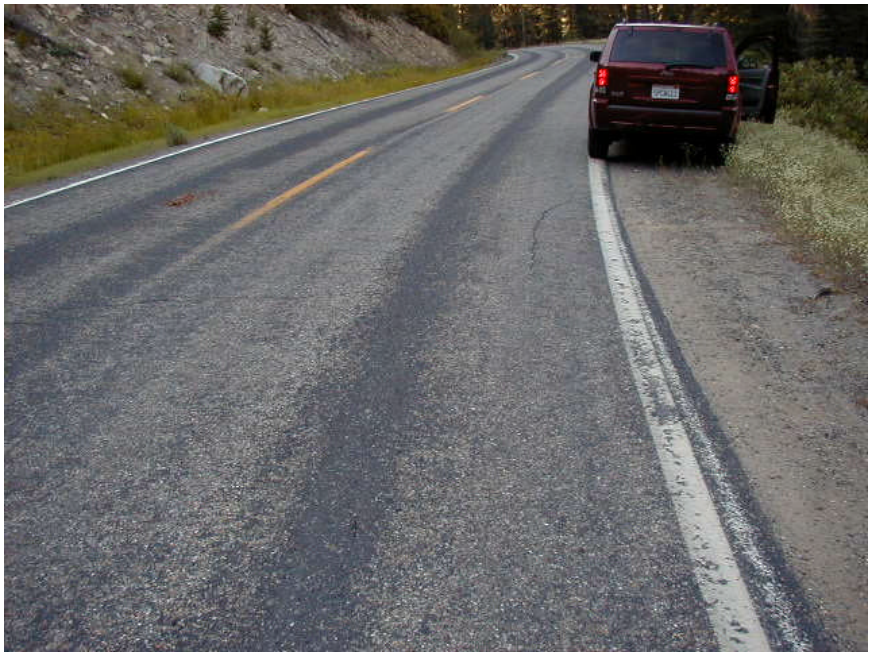
MP 6.7 Looking East – Sound Pavement

MP 7.8 Minor Rutting EBL

MP 7.8 Minor Rutting EBL

MP 8.1 looking west – tearing and shoving in top mat from heavy logging trucks

MP 8.1 Close-up of shoved top mat in EBL, WBL minor block cracking



MP 8.1 Looking east, small edge crack EBL, and low severity transverse in WBL

MP 8.1+ Alligator cracking WBL – spot location, note water in ditch

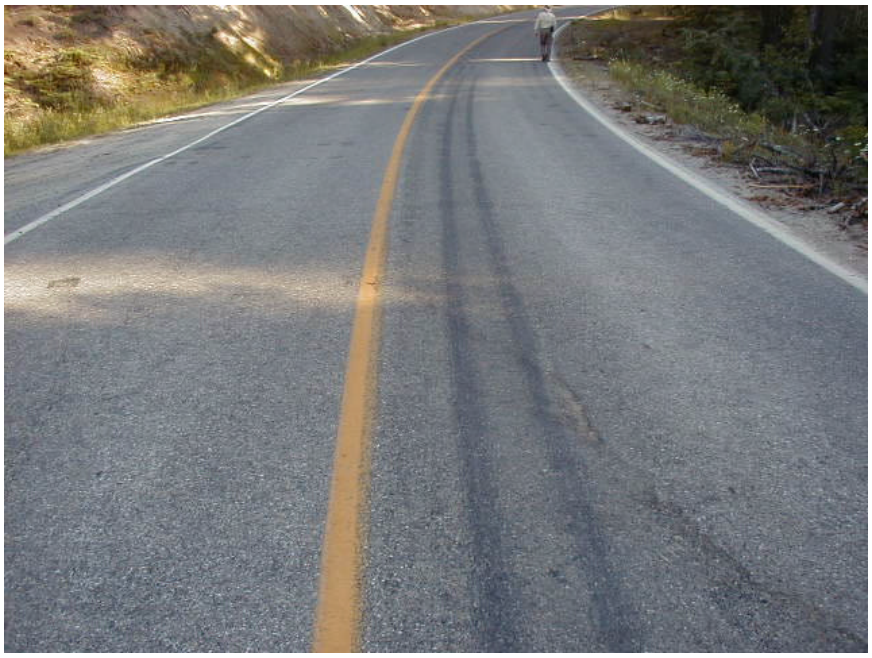
MP 8.1+ Small slide and suspected water source above roadway

MP 8.5 Looking East -start new chip seal – Sound Pavement

MP 8.7 to 8.9 large patch

MP 8.8 Minor rutting and block cracking

MP 9.0 Longitudinal tear in top mat in right wheel path of EBL



MP 9.5 Damaged Chip Seal

MP 9.9 Edge Patch of WBL – remainder in good condition

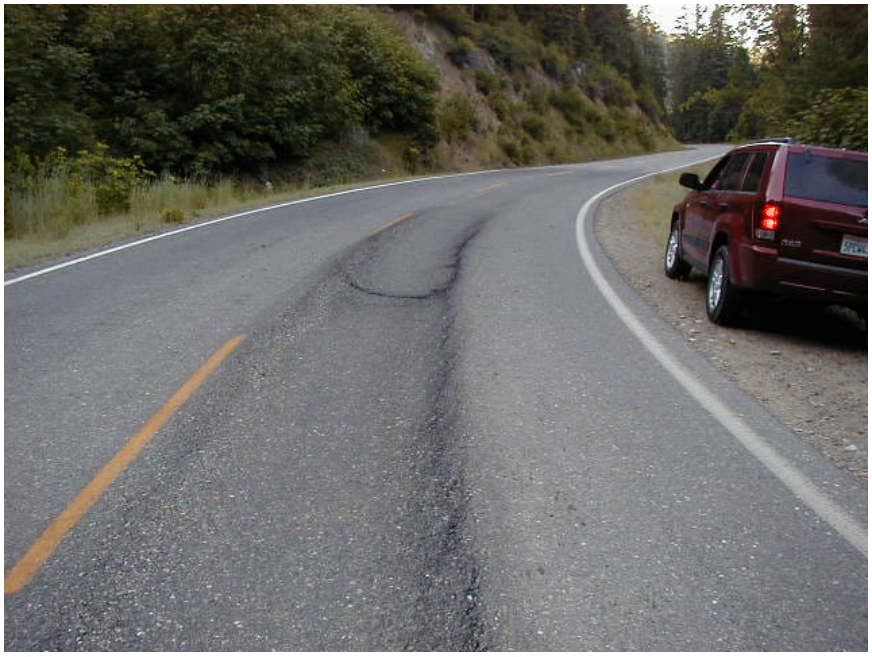
MP 10.1 EBL slump failure, probably will require deep patch

MP 10.2 Looking West – Sound Pavement

MP 10.2 Looking east, patch in EBL

MP 10.4 Patched Slump at edge of pavement

MP 10.5 Looking east – patch in EBL



MP 10.7 Shove in top mat of EBL

MP 10.7 Close-up of shoved pavement

MP 10.7 EBL Close-up of shoved area showing exposed lower mat

(No work area between MP 10.7 and 11.9)

MP 10.8 Shoving in EBL, probably caused by heavy logging trucks

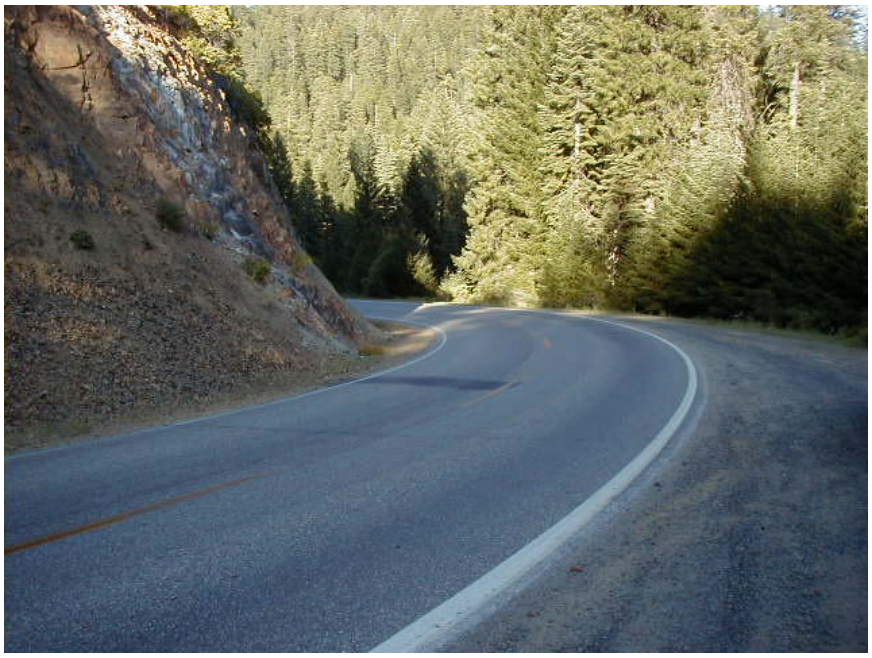
MP 10.8 Close-up of shoved EBL

MP 11.1 Slump failure in EBL probably will need deep patching

MP 11.6 Scar in chip seal – sound pavement

MP 11.8 ½-inch Rutting

MP 11.8 Rutting in EBL

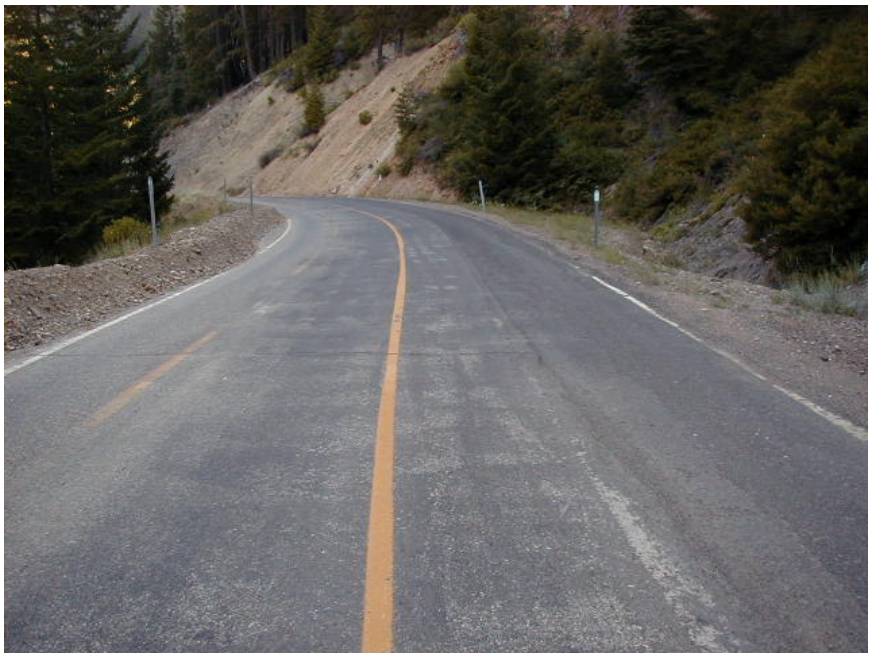


MP 11.9 Resume Project looking east

MP 11.9 High Severity Transverse Cracking

MP 11.9+ Looking west across slide area

MP 11.9+ Slide Area



MP 11.9+ Slide area pavement, note widening in WBL – looking west

MP 12.1 block and linear cracking plus patch in WBL

MP 12.1 Minor Block cracking in WBL

MP 12.4 Minor Block and Edge Cracking

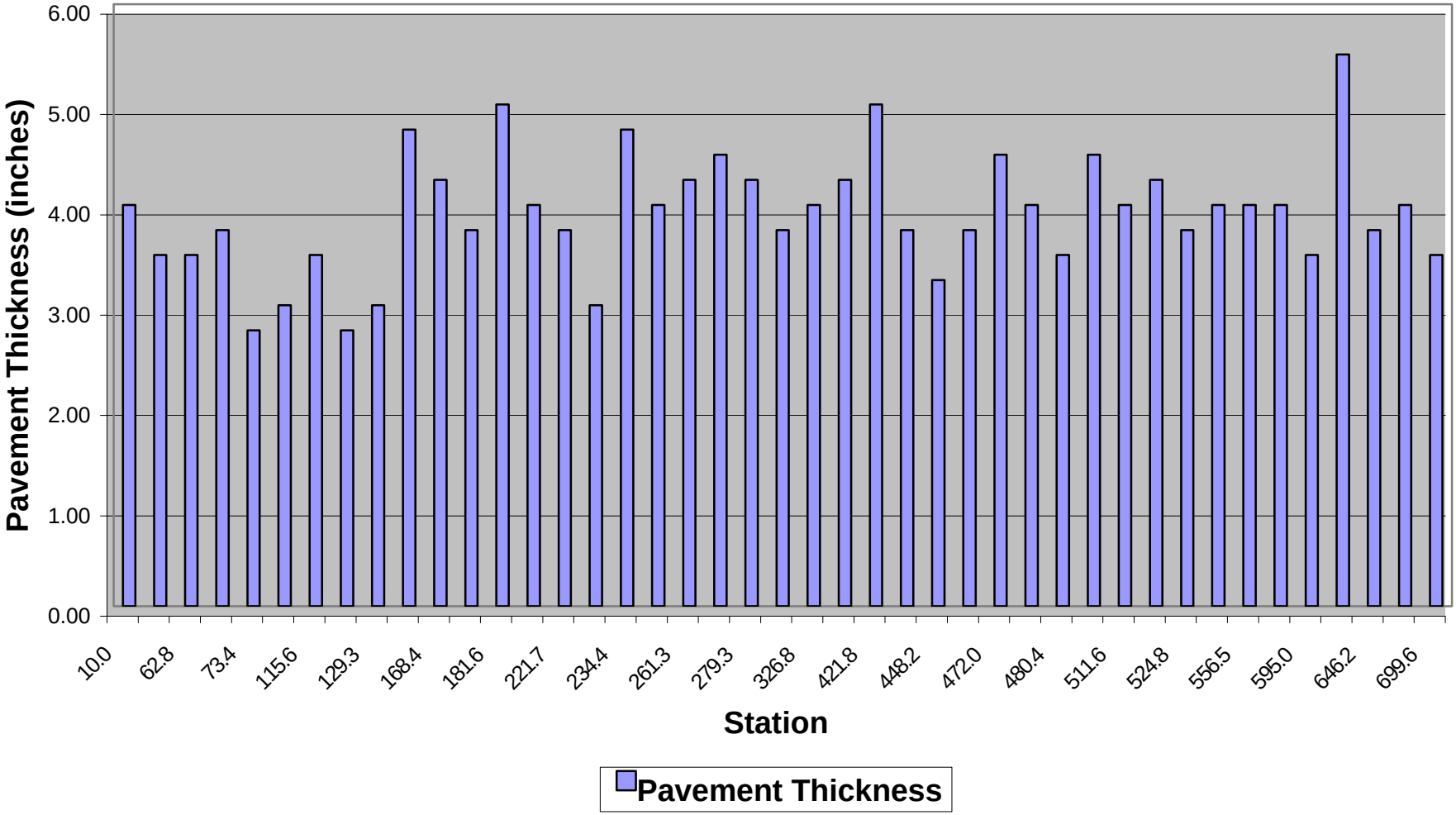
MP 12.5 Transverse cracking

MP 12.8 Looking West

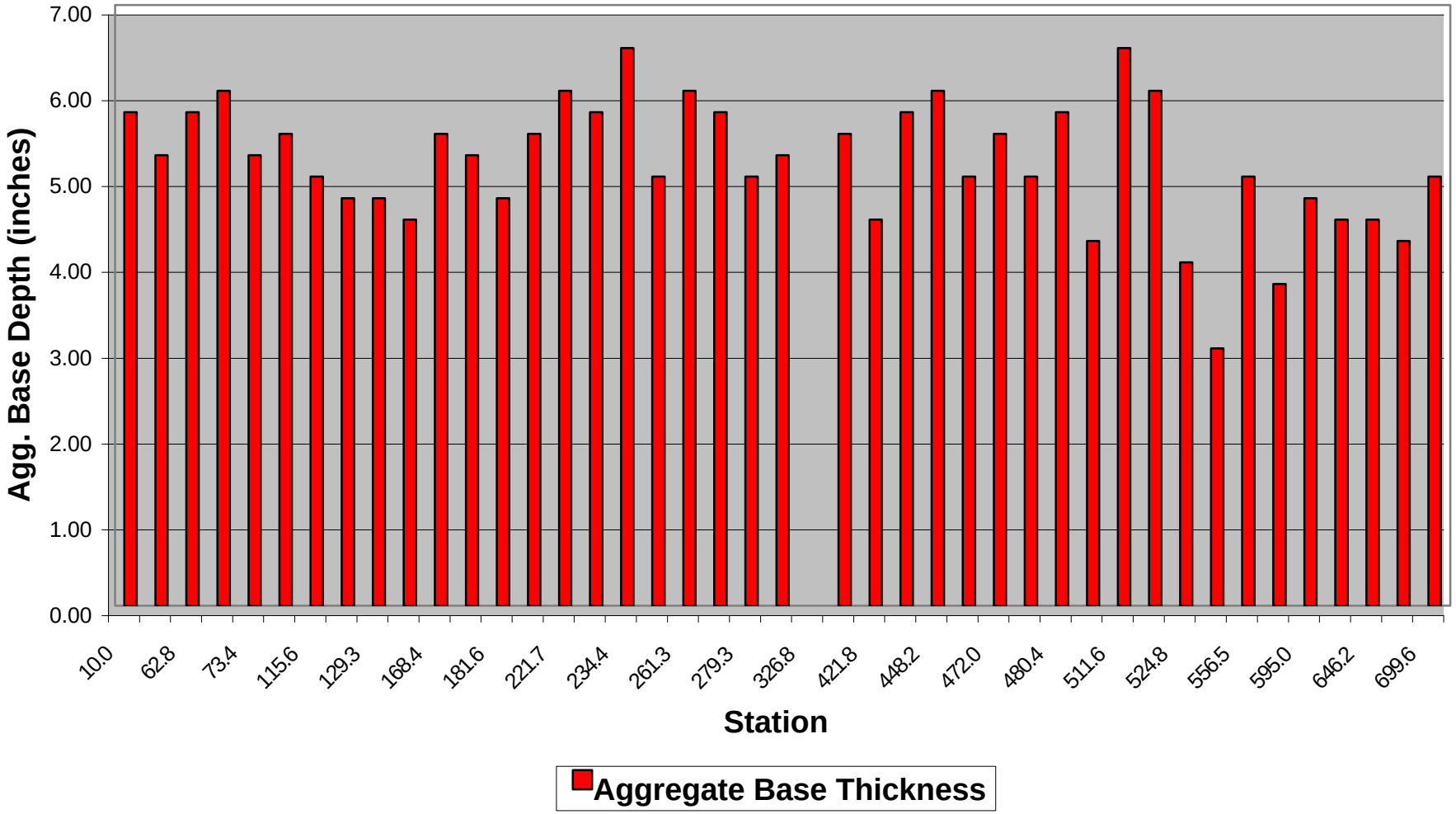
MP 13.0 Looking west toward project

APPENDIX B
Pavement and Base Thickness Graphs

Pavement Thickness versus Station
Quincy - Oroville Road, CA.
CA-PFH 119-1(3)



Aggregate Base versus Station
Quincy-Oroville Road, Ca.
CA-PFH 119-1(3)



APPENDIX C
Laboratory Test Results

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 25 - 193 Project Name: Quincy - Oroville Road, Ca. Date: 9/28/2006

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	% Swell (+) / Consoli-dation (-)	Unconf. Comp. Strength (psf)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI						AASHTO	USCS
# 17	5	Bulk	7.9	–	19	35	46	31	22	9	–	–	–	–	–	A - 4 (1)	SC
# 18	5	Bulk	5.1	–	16	65	20	NV	NP	NP	–	–	–	–	–	A-2-4 (0)	SM
# 19	5	Bulk	3.6	–	25	43	32	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM
# 20	5	Bulk	6.7	–	16	42	42	28	20	8	–	–	–	–	36**	A - 4 (0)	SC
# 22	5	Bulk	7.3	–	14	50	36	NV	NP	NP	–	–	–	–	–	A - 4 (0)	SM
# 24	5	Bulk	2.2	–	22	49	29	NV	NP	NP	–	–	–	–	62*	A-2-4 (0)	SM
Pt- 1	5	Bulk	8.1	–	50	34	16	33	22	11	–	–	–	–	19	A-2-6 (0)	GC
Pt- 2	5	Bulk	3.5	–	46	44	10	NV	NP	NP	–	–	–	–	–	A-1-a (0)	GW - GM
Pt- 3	5	Bulk	8.7	–	53	36	11	NV	NP	NP	–	–	–	–	–	A-1-a (0)	GP - GM
Pt- 4	5	Bulk	6.1	–	47	40	13	NV	NP	NP	–	–	–	–	81	A-1-a (0)	GM
Pt- 5	5	Bulk	4.3	–	43	49	8	NV	NP	NP	–	–	–	–	–	A-1-a (0)	SW - SM

* Combined Samples 3, 7, 13, 16, 19, and 24

** Combined Samples 5, 6, 10, and 20

APPENDIX D
Boring Logs and Engineering Geology

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **1**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 1.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 12.2 % #200= 37 % LL= 41 PL= 31 PI= 10 AASHTO: A - 5 (0) USCS: SM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **2**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 2.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.2 ft. Asphalt.	
								0.2 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. silty GRAVEL, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 6.8 % #200= 27 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: GM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **3**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 3.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. silty SAND, blue-gray, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 62 MC= 6.8 % #200= 34 % LL= NV PL= NP PI= NP pH= 6.2 S= 0 % Re= 13900 ohms-cm AASHTO: A-2-4 (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **4**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.4 ft. Asphalt.	
								0.4 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
	5							Bottom of Hole at 5.0 ft.	MC= 17.6 % #200= 32 % LL= 43 PL= 39 PI= 4 pH= 5.9 S= 0.003 % AASHTO: A-2-5 (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **5**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 5.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 36 MC= 9.1 % #200= 38 % LL= 30 PL= 25 PI= 5 AASHTO: A - 4 (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **6**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 6.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.4 ft. Asphalt.	
								0.4 - 0.8 ft. Base Coures.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 36 MC= 11.5 % #200= 40 % LL= 31 PL= 28 PI= 3 AASHTO: A - 4 (0) USCS: SM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **7**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 7.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.4 ft. Asphalt.	
								0.4 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 62 MC= 5.5 % #200= 31 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: SM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **8**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 8.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 11.1 % #200= 14 % LL= NV PL= NP PI= NV AASHTO: A-2-4 (0) USCS: SM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **9**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 9.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.9 ft. Base Course.	
								0.9 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 8 % #200= 38 % LL= NV PL= NP PI= NP AASHTO: A - 4 (0) USCS: SM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **10**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 10.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 36 MC= 3.3 % #200= 42 % LL= 32 PL= 27 PI= 5 Re= 9500 ohms-cm AASHTO: A - 4 (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **11**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 11.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/18/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. silty GRAVEL, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 5.4 % #200= 24 % LL= 31 PL= 25 PI= 6 AASHTO: A-1-b (0) USCS: GM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **12**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 12.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. clayey COBBLES, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 4 % #200= 21 % LL= 32 PL= 23 PI= 9 AASHTO: A-2-4 (0) USCS: GC

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **13**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 13.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.6 ft. Base Course.	
								0.6 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 62 MC= 3.2 % #200= 29 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **14**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 14.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.4 ft. Asphalt.	
								0.4 - 0.9 ft. Base Course.	
								0.9 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 4.2 % #200= 19 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **15**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 15.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 7.9 % #200= 24 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SM

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **16**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 16.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.4 ft. Asphalt.	
								0.4 - 0.9 ft. Base Course.	
								0.9 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 62 MC= 5.5 % #200= 32 % LL= NV PL= NP PI= NV AASHTO: A-2-4 (0) USCS: SM

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GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **17**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 17.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. clayey SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 7.9 % #200= 46 % LL= 31 PL= 22 PI= 9 AASHTO: A - 4 (1) USCS: SC

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Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **18**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 18.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 5.1 % #200= 20 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: SM

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Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **19**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 19.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 3.6 % #200= 32 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: SM

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Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **20**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 20.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. clayey SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 36 MC= 6.7 % #200= 42 % LL= 28 PL= 20 PI= 8 AASHTO: A - 4 (0) USCS: SC

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GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **22**
Sheet 1 of 1

Boring Began: 9/19/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/19/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 21.0

Ground Water Notes:

Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. Asphalt.	
								0.3 - 0.7 ft. Base Course.	
								0.7 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	MC= 7.3 % #200= 36 % LL= NV PL= NP PI= NP AASHTO: A - 4 (0) USCS: SM

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Project: Quincy Oroville, CA
Project Number: 25 - 193 Date:

Boring: **24**
Sheet 1 of 1

Boring Began: 9/18/2006
Drilling Method: Solid-Stem Auger
Drill: CME 45B
Driller: Technicon Engineering
Logged By: J. Lovekin
Final By: M. Aichiouene
Inclination: Vertical

Completed: 9/18/2006
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation: 0.0 ft
Location:
Coordinates: N: 0.0 E: 22.0

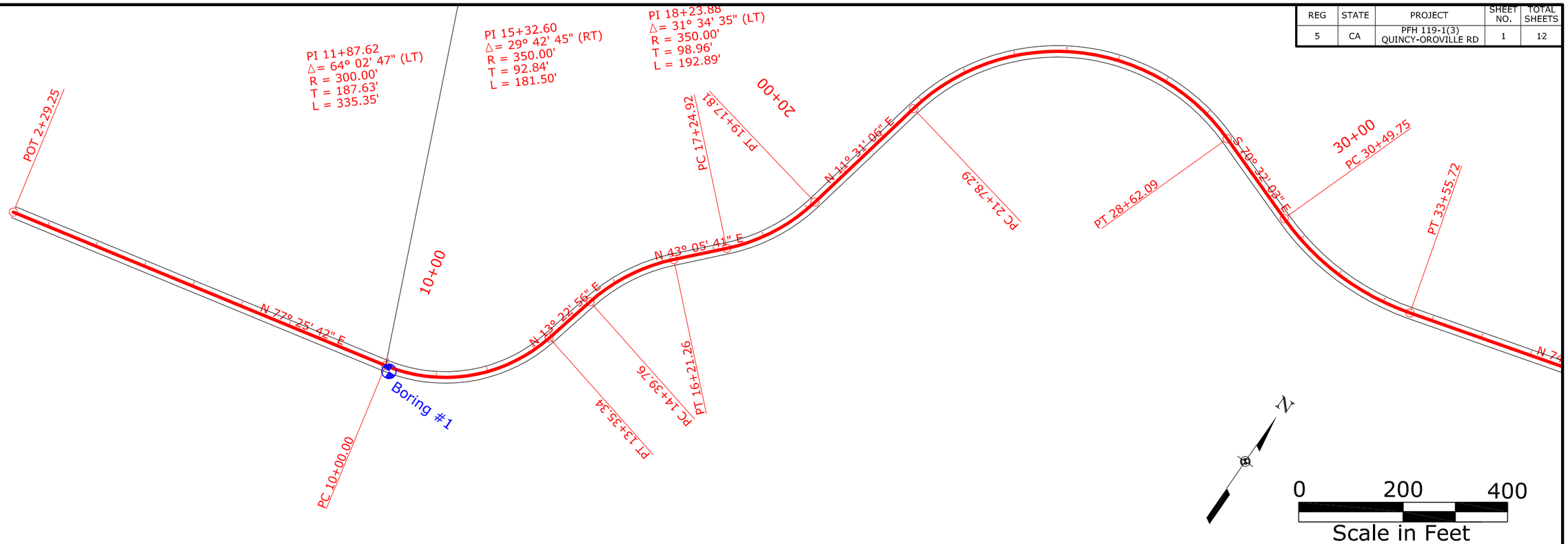
Ground Water Notes:

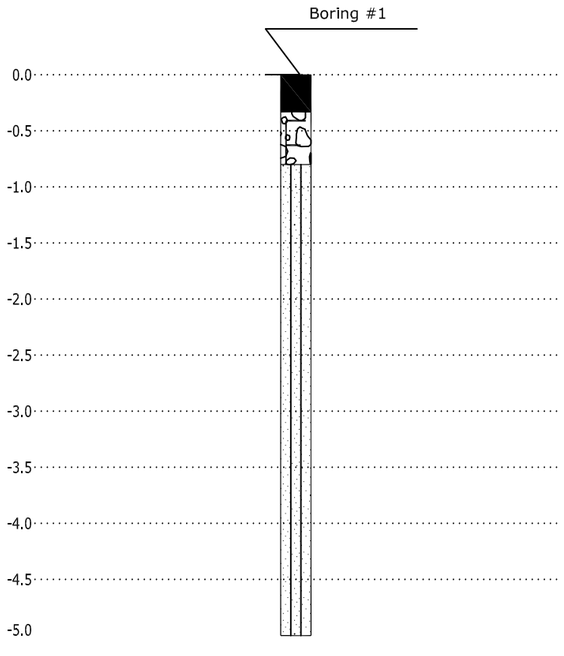
Depth	▽ Dry	-	-	-
Date	9/19/06	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.5 ft. Asphalt.	
								0.5 - 0.8 ft. Base Course.	
								0.8 - 5.0 ft. silty SAND, brown, moist.	
-5	5							Bottom of Hole at 5.0 ft.	R-Value = 62 MC= 2.2 % #200= 29 % LL= NV PL= NP PI= NP AASHTO: A-2-4 (0) USCS: SM

BORING LOG 25-193 QUINCY OROVILLE, CA.GPJ YEH ASSOCIATES.GDT 2/6/07

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	1	12



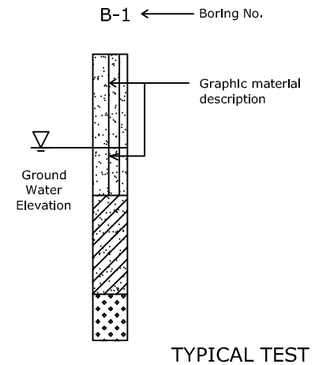


LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine< #200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 1	5	Bulk	12.2	26	37	37	41	31	10	-	-	-	-	SM	A-5 (0)

Yeh and Associates, Inc.
Consulting Geotechnical Engineers

5700 E. Evans Ave. Denver, CO 80222
Phone: (303)781-9590 Fax: (303) 781-9583

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY STANDARD

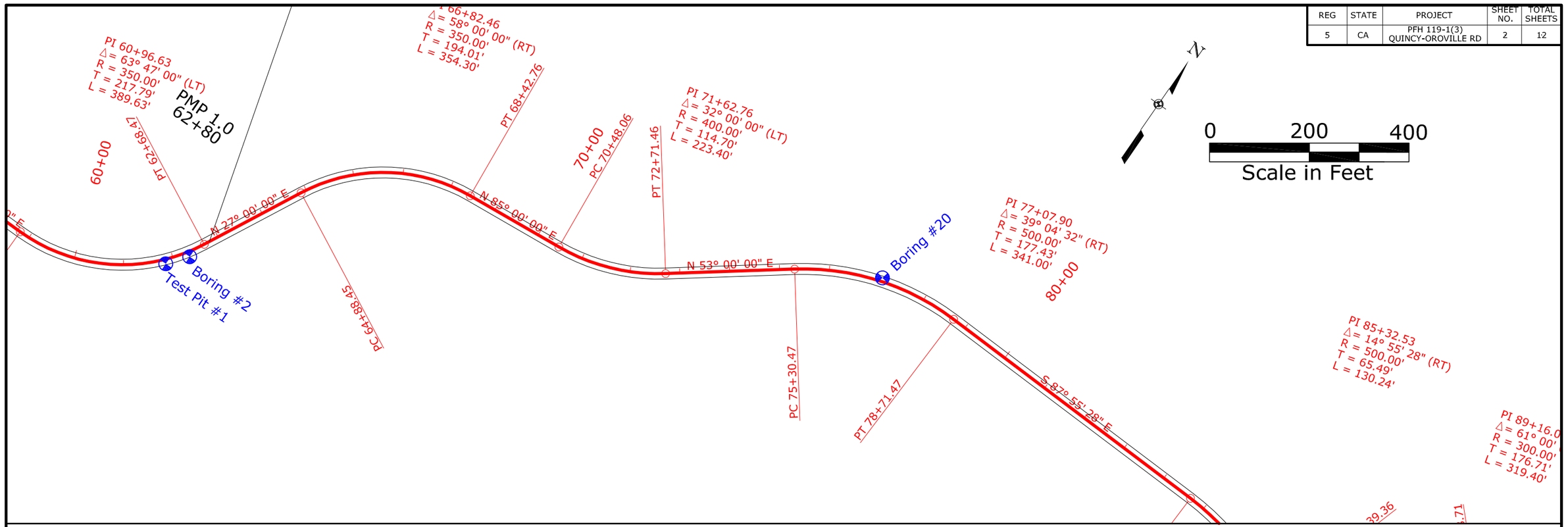
Engineering Geology Sheet STA. 2+29 to STA. 36+00

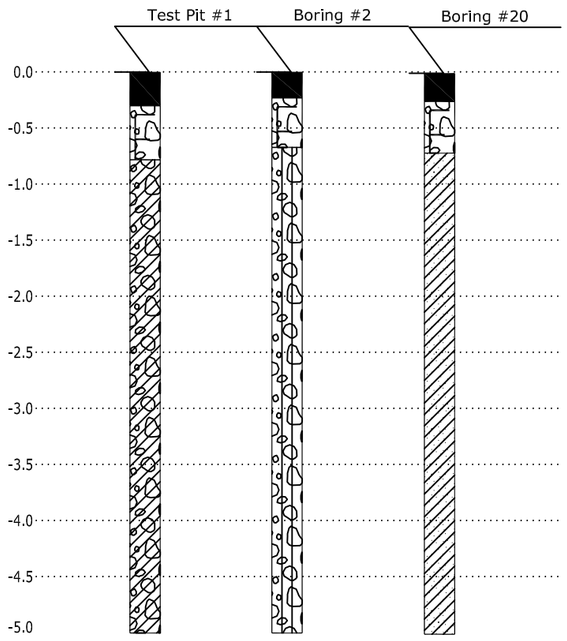
STANDARD APPROVED FOR USE XX/XX

REVISED: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	2	12





SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine<#200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Test Pit 1	5	Bulk	8.1	50	34	16	33	22	11	-	-	-	19	GC	A-2-6 (0)
Boring 2	5	Bulk	6.8	40	33	27	NV	NP	NP	-	-	-	-	GM	A-2-4 (0)
Boring 20	5	Bulk	6.7	16	42	42	28	20	8	-	-	-	36*	SC	A-4 (0)

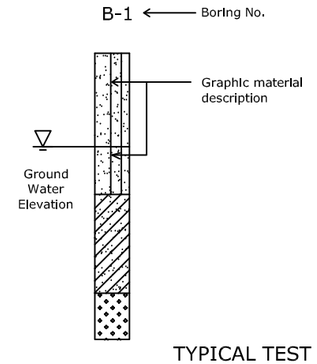
* Combined Samples 5,6,10 and 20

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Clayey Sand
- USCS Silty Gravel
- USCS Clayey Gravel

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

Yeh and Associates, Inc.
Consulting Geotechnical Engineers
5700 E. Evans Ave. Denver, CO 80222
Phone: (303)781-9590 Fax: (303) 781-9583

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY STANDARD

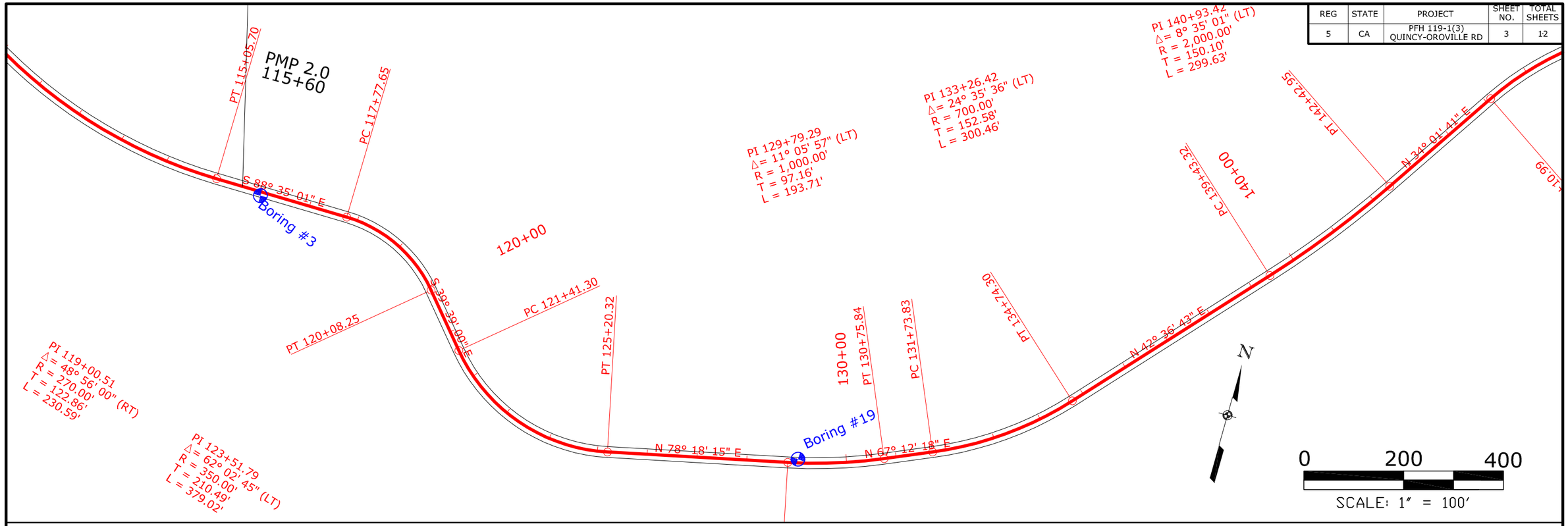
Engineering Geology Sheet STA. 58+50 to STA. 85+50

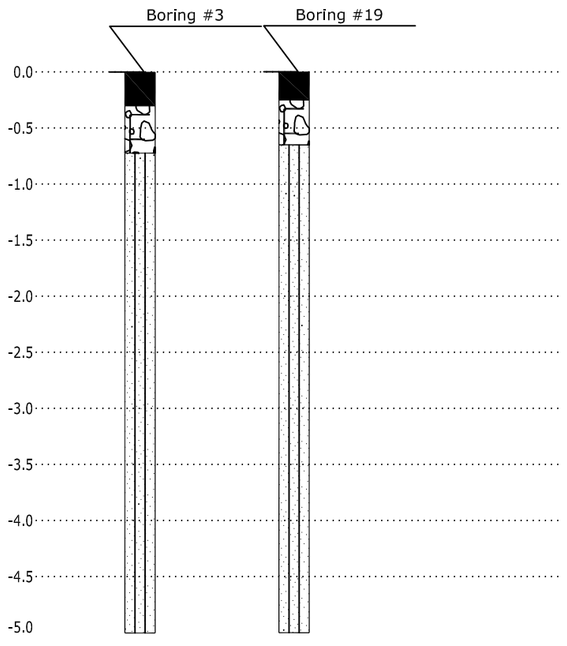
STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	3	12





SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine<#200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 3	5	Bulk	6.8	30	36	34	NV	NP	NP	6.2	13900	0.000	62*	SM	A-2-4 (0)
Boring 19	5	Bulk	3.6	25	43	32	NV	NP	NP	-	-	-	62*	SM	A-2-4 (0)

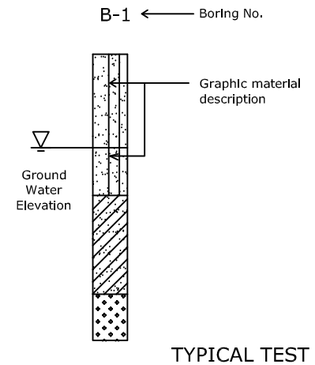
* Combined Samples 5,6,10 and 20

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

Yeh and Associates, Inc.
Consulting Geotechnical Engineers
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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
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U.S. CUSTOMARY STANDARD

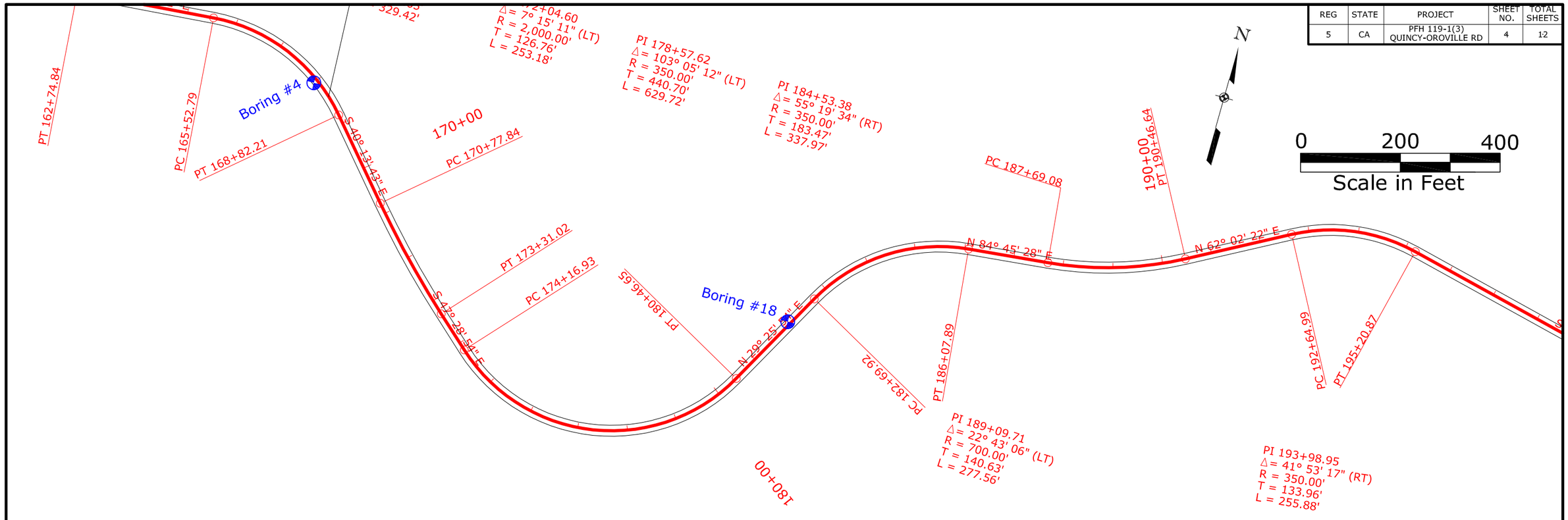
Engineering Geology Sheet
STA. 111+00 to STA. 147+00

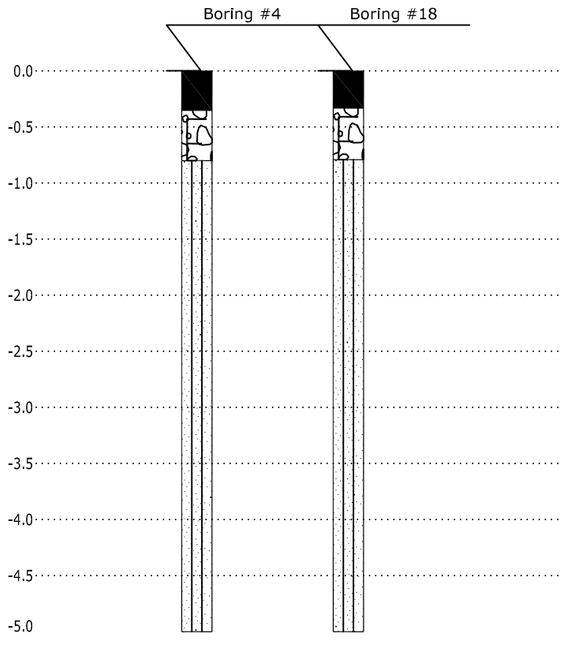
STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	4	12





SUMMARY OF TEST RESULTS

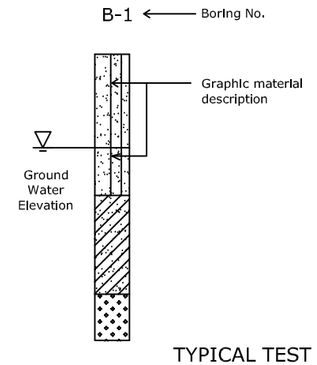
Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine< #200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 4	5	Bulk	17.6	28	40	32	43	39	4	5.9	-	0.003	-	SM	A-2-5 (0)
Boring 18	5	Bulk	5.1	16	65	20	NV	NP	NP	-	-	-	-	SM	A-2-4 (0)

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

Yeh and Associates, Inc.
Consulting Geotechnical Engineers
5700 E. Evans Ave. Denver, CO 80222
Phone: (303)781-9590 Fax: (303) 781-9583

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U.S. CUSTOMARY STANDARD

Engineering Geology Sheet STA. 161+50 to STA. 198+50

STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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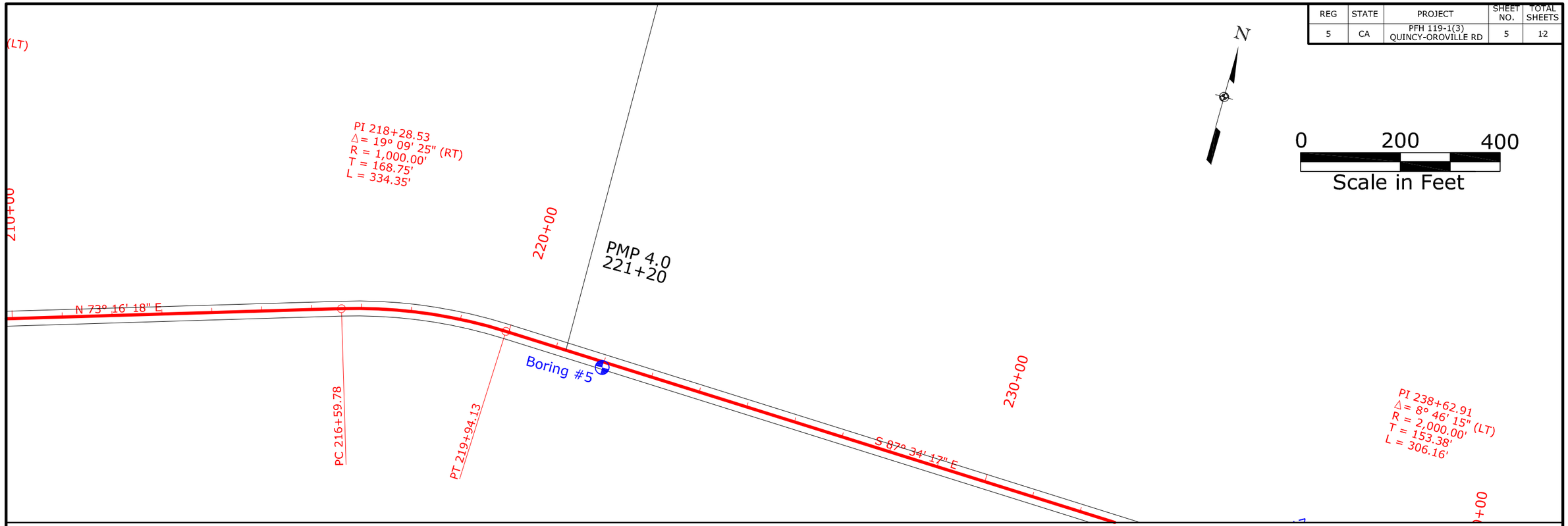
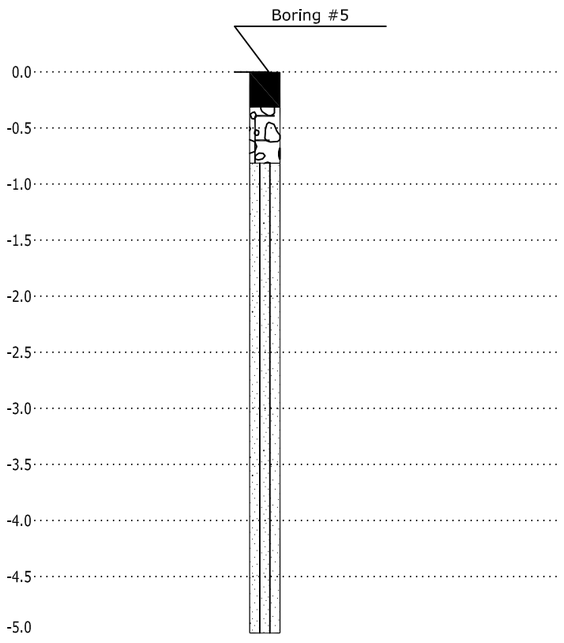




SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sieve Analysis AASHTO Sand	Sieve Analysis AASHTO Fine<#200	Atterberg Limits Liquid Limit	Atterberg Limits Plastic Limit	Atterberg Limits Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 5	5	Bulk	9.1	21	41	38	30	25	5	-	-	-	36*	SM	A-4 (0)

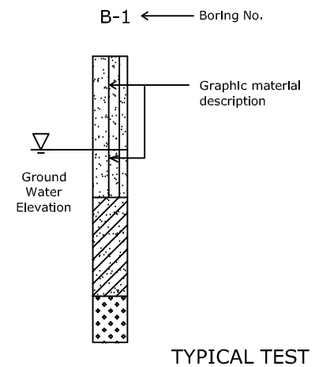
* Combined Samples 5, 6, 10, and 20

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

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U.S. CUSTOMARY STANDARD

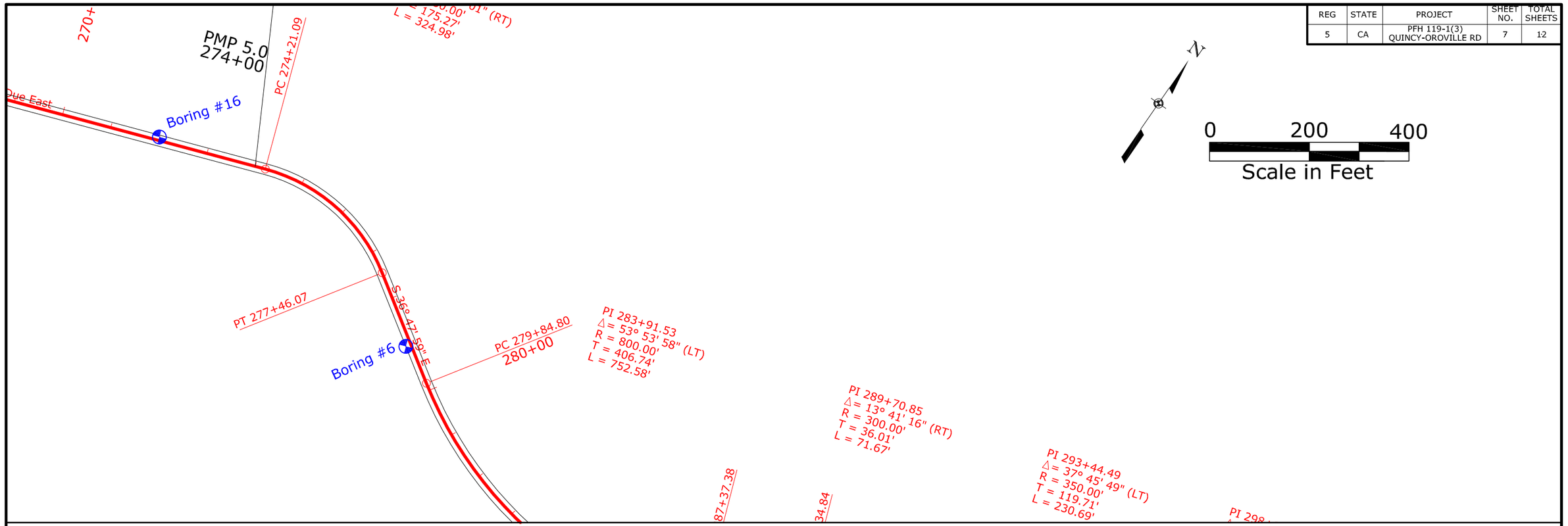
Engineering Geology Sheet STA. 210+00 to STA. 232+50

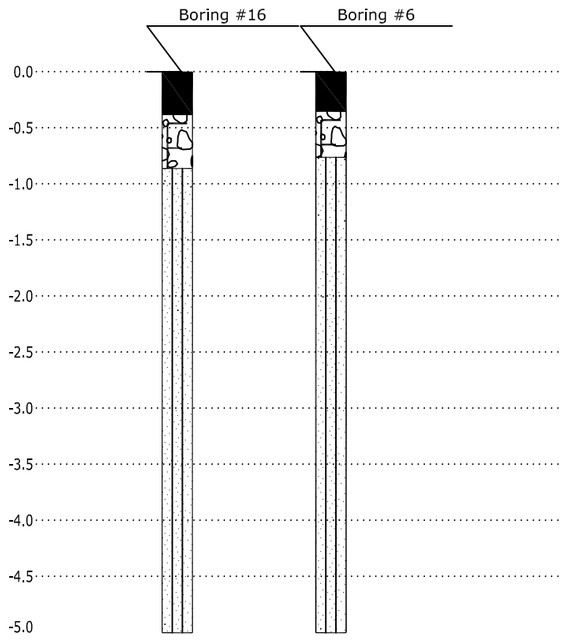
STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	7	12





SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine<#200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 6	5	Bulk	11.5	19	41	40	31	28	3	-	-	-	36*	SM	A-4 (0)
Boring 16	5	Bulk	5.5	14	54	32	NV	NP	NP	-	-	-	62**	SM	A-2-4 (0)

* Combined Samples 5, 6, 10, and 20

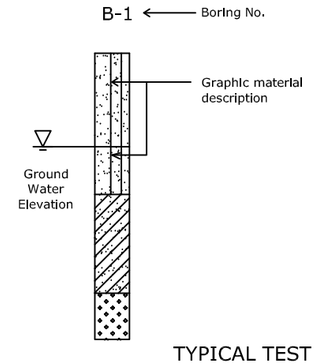
** Combined Samples 3, 7, 13, 16, 19, and 24

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

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Engineering Geology Sheet STA. 269+00 to STA. 283+00

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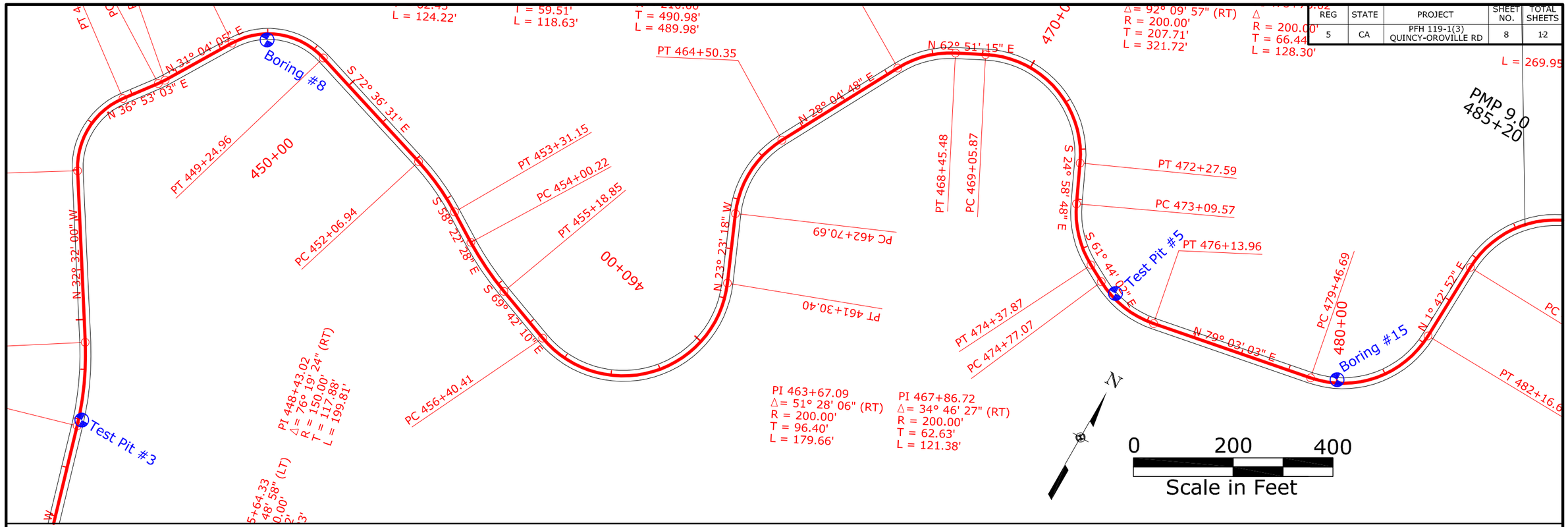
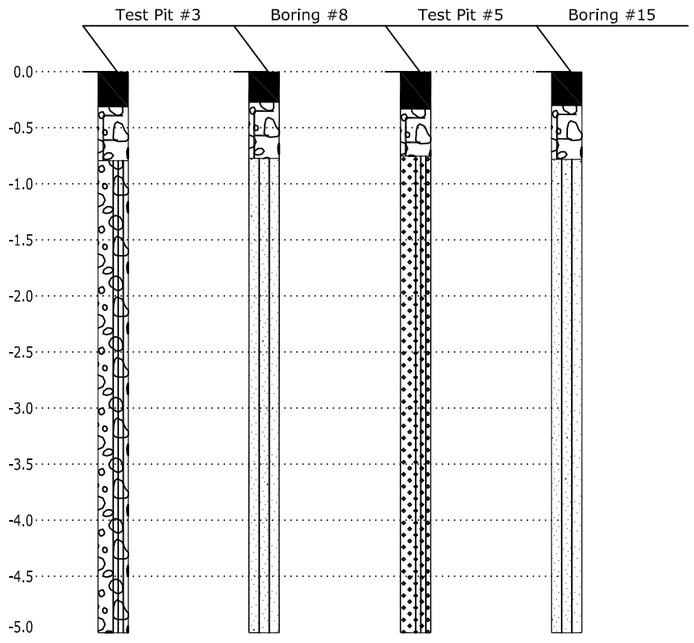
STANDARD



REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	8	12



SUMMARY OF TEST RESULTS

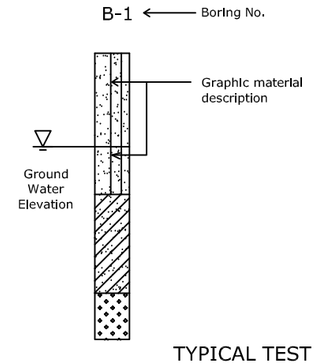
Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine<#200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Test Pit 3	5	Bulk	8.7	53	36	11	NV	NP	NP	-	-	-	-	GP-GM	A-1-a (0)
Boring 8	5	Bulk	11.1	18	68	14	NV	NP	NP	-	-	-	-	SM	A-2-4 (0)
Test Pit 5	5	Bulk	4.3	43	49	8	NV	NP	NP	-	-	-	-	SW-SM	A-1-a (0)
Boring 15	5	Bulk	7.9	10	66	24	NV	NP	NP	-	-	-	-	SM	A-1-b (0)

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand
- USCS Poorly-graded Gravel with Silt
- USCS Well-graded Sand with Silt

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

Yeh and Associates, Inc.
Consulting Geotechnical Engineers
5700 E. Evans Ave. Denver, CO 80222
Phone: (303)781-9590 Fax: (303) 781-9583

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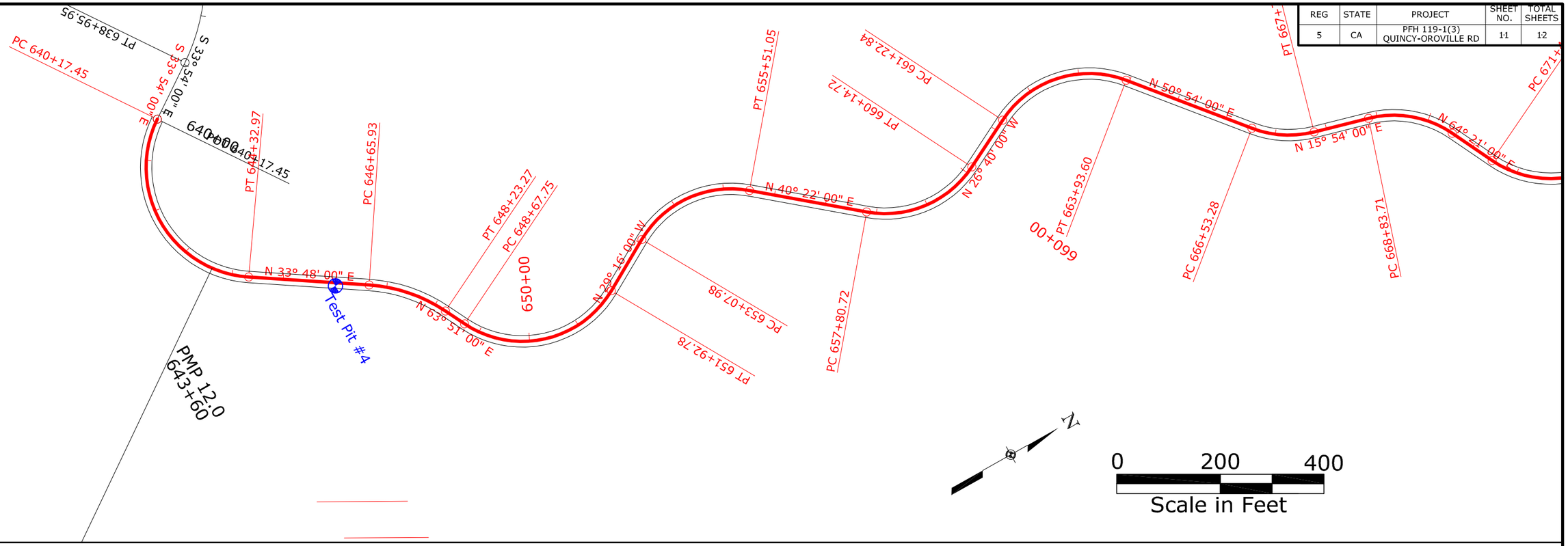
Engineering Geology Sheet STA. 436+00 to STA. 485+50

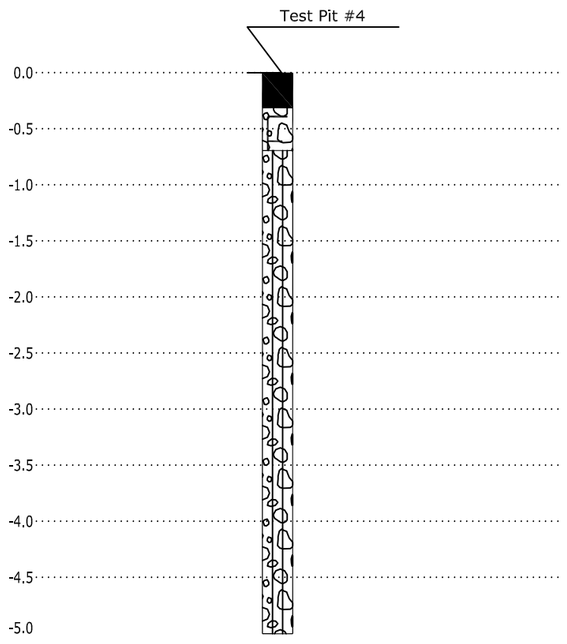
STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	11	12





SUMMARY OF TEST RESULTS

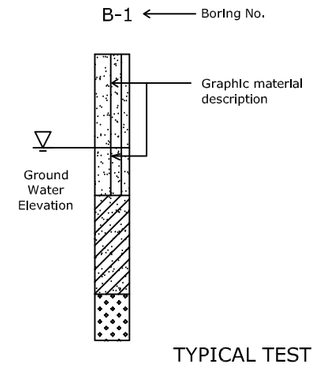
Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine<#200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Test Pit 4	5	Bulk	6.1	47	40	13	NV	NP	NP	-	-	-	81	GM	A-1-a (0)

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand
- USCS Silty Gravel

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

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Consulting Geotechnical Engineers
5700 E. Evans Ave. Denver, CO 80222
Phone: (303)781-9590 Fax: (303) 781-9583

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U.S. CUSTOMARY STANDARD

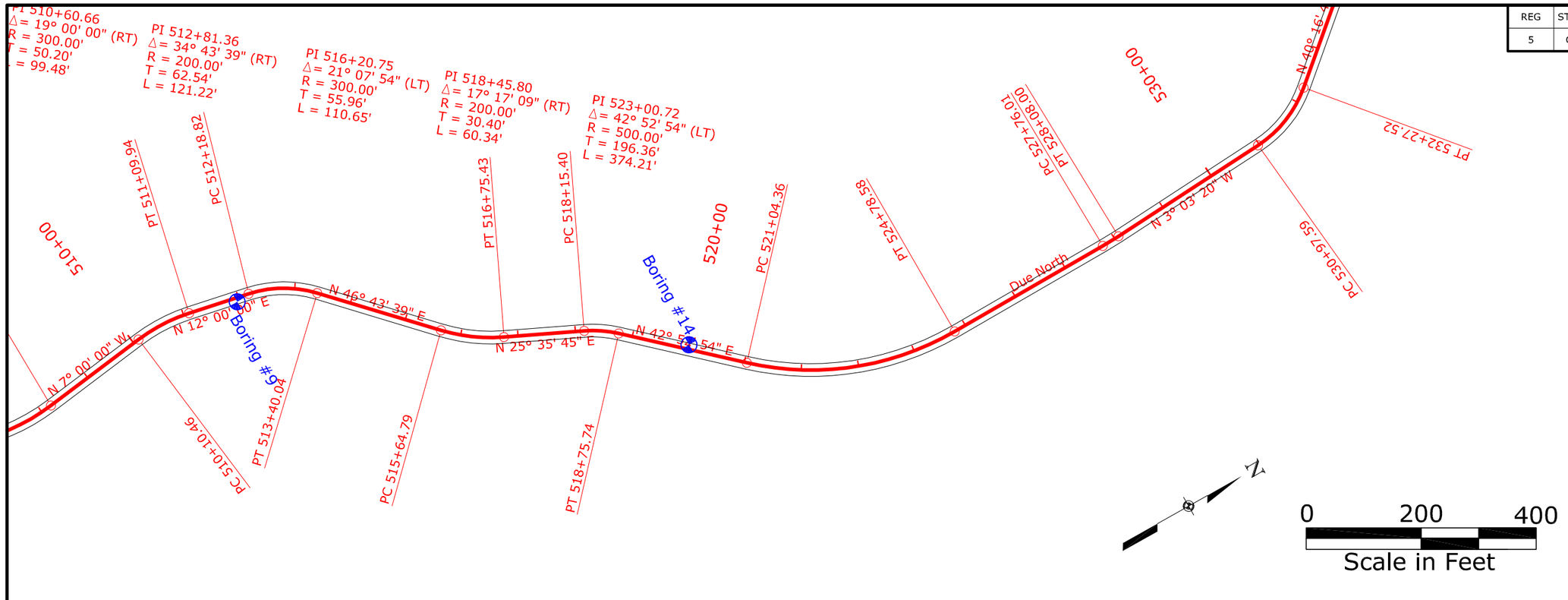
Engineering Geology Sheet STA. 640+17 to STA. 672+50

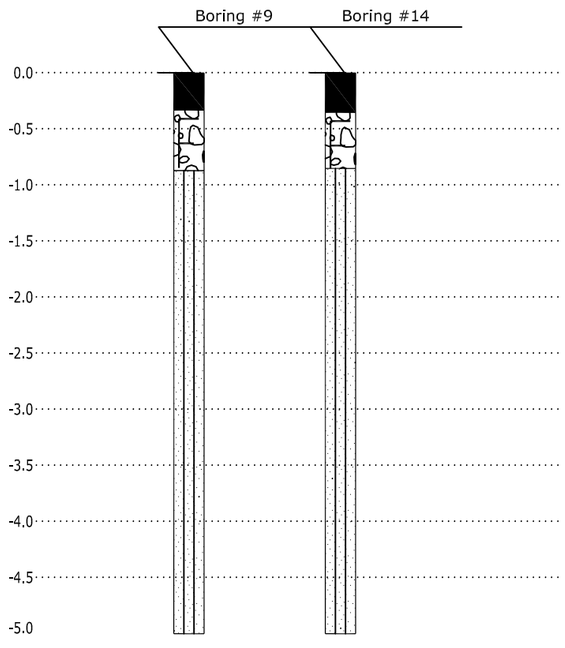
STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	9	12



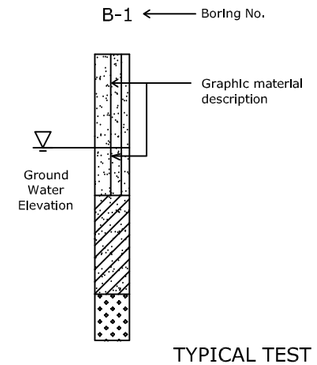


LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sieve Analysis AASHTO Sand	Sieve Analysis AASHTO Fine< #200	Atterberg Limits Liquid Limit	Atterberg Limits Plastic Limit	Atterberg Limits Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 9	5	Bulk	8.0	13	49	38	NV	NP	NP	-	-	-	-	SM	A-4 (0)
Boring 14	5	Bulk	4.2	21	60	19	NV	NP	NP	-	-	-	-	SM	A-1-b (0)

Yeh and Associates, Inc.
Consulting Geotechnical Engineers
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Phone: (303)781-9590 Fax: (303) 781-9583

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CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY STANDARD

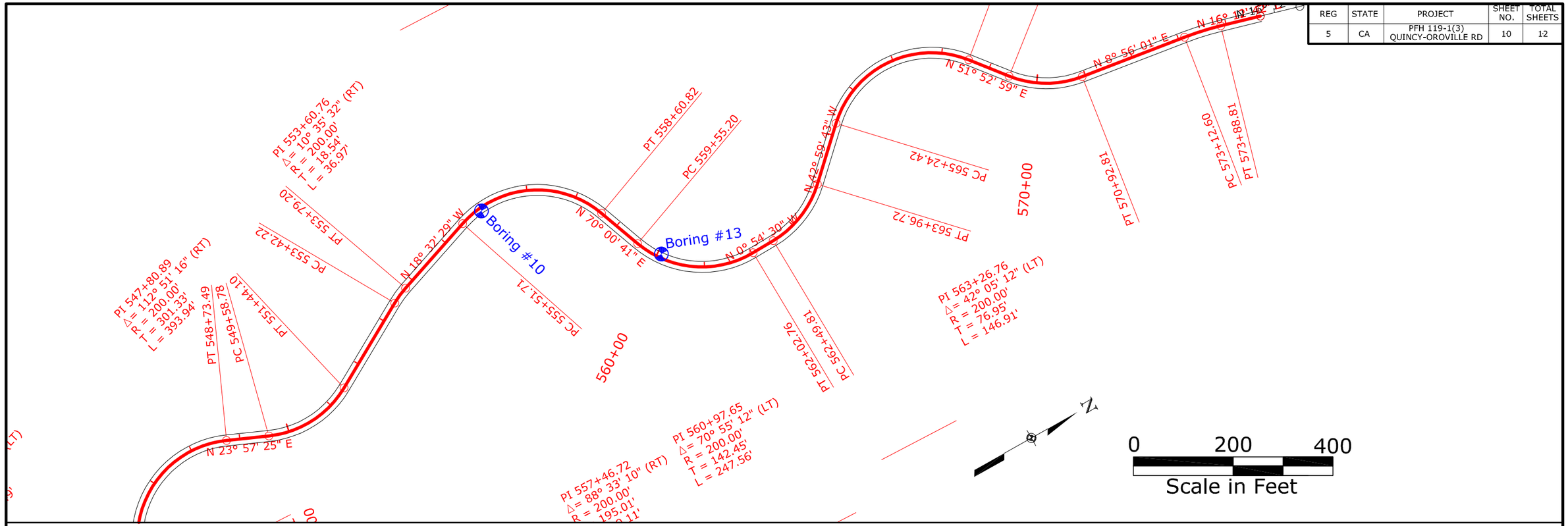
Engineering Geology Sheet
STA. 507+50 to STA. 533+75

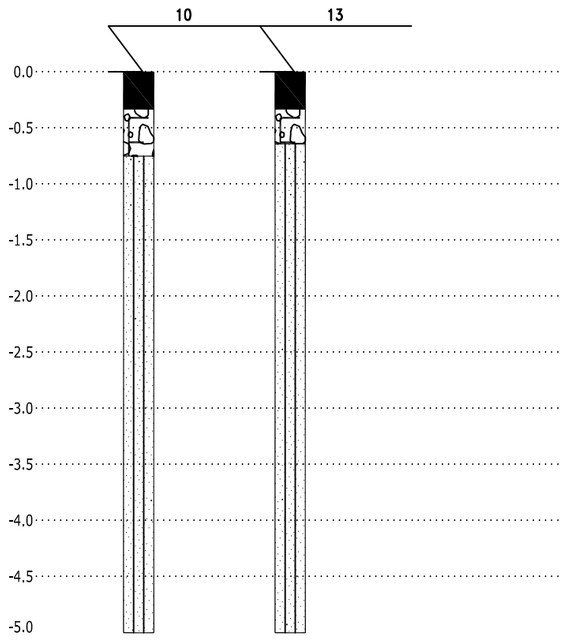
STANDARD APPROVED FOR USE XX/XX

REVISED: _____ _____ _____ _____ _____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	10	12



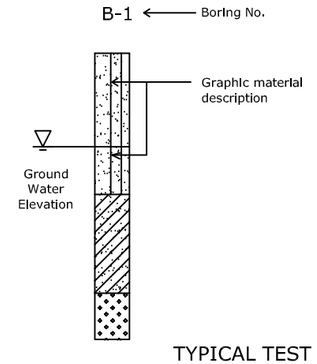


LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine< #200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 10	5	Bulk	3.3	9	49	42	32	27	5	-	9500	-	36*	SM	A-4 (0)
Boring 13	5	Bulk	3.2	33	38	29	NV	NP	NP	-	-	-	62**	SM	A-2-4 (0)

* Combined Samples 5, 6, 10, and 20

** Combined Samples 3,7, 13, 16, 19, and 24

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U.S. CUSTOMARY STANDARD

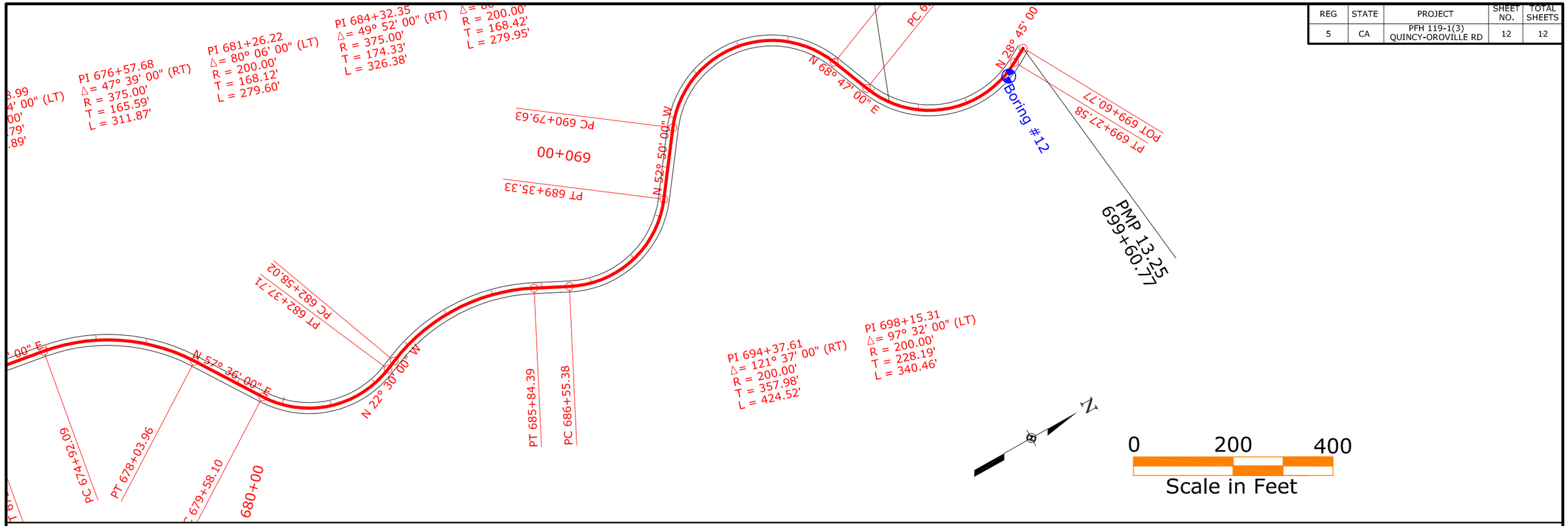
Engineering Geology Sheet STA. 546+25 to STA. 590+75

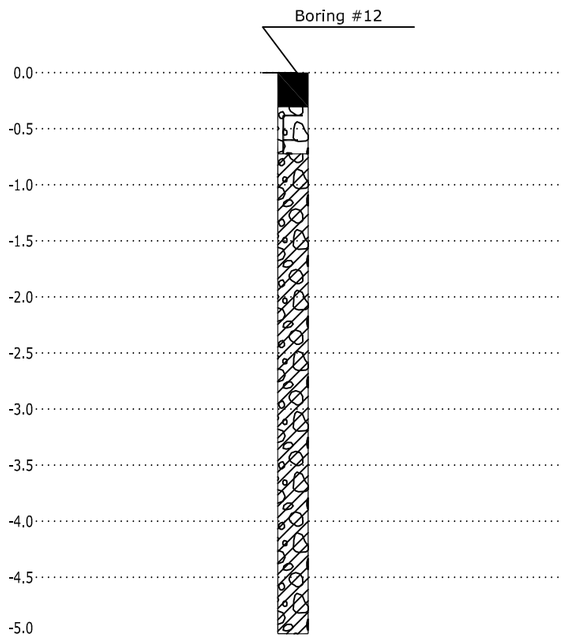
STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
5	CA	PFH 119-1(3) QUINCY-OROVILLE RD	12	12



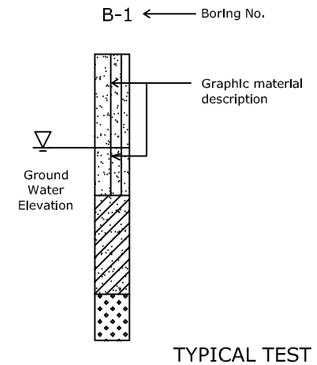


LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Silty Sand
- USCS Clayey Gravel

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

SUMMARY OF TEST RESULTS

Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine< #200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Boring 12	5	Bulk	4.0	43	36	21	32	23	9	-	-	-	-	GC	A-2-4 (0)

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U.S. CUSTOMARY STANDARD

Engineering Geology Sheet
STA. 674+25 to STA. 699+60

STANDARD APPROVED FOR USE XX/XX

REVISED: _____ _____ _____ _____ _____

STANDARD

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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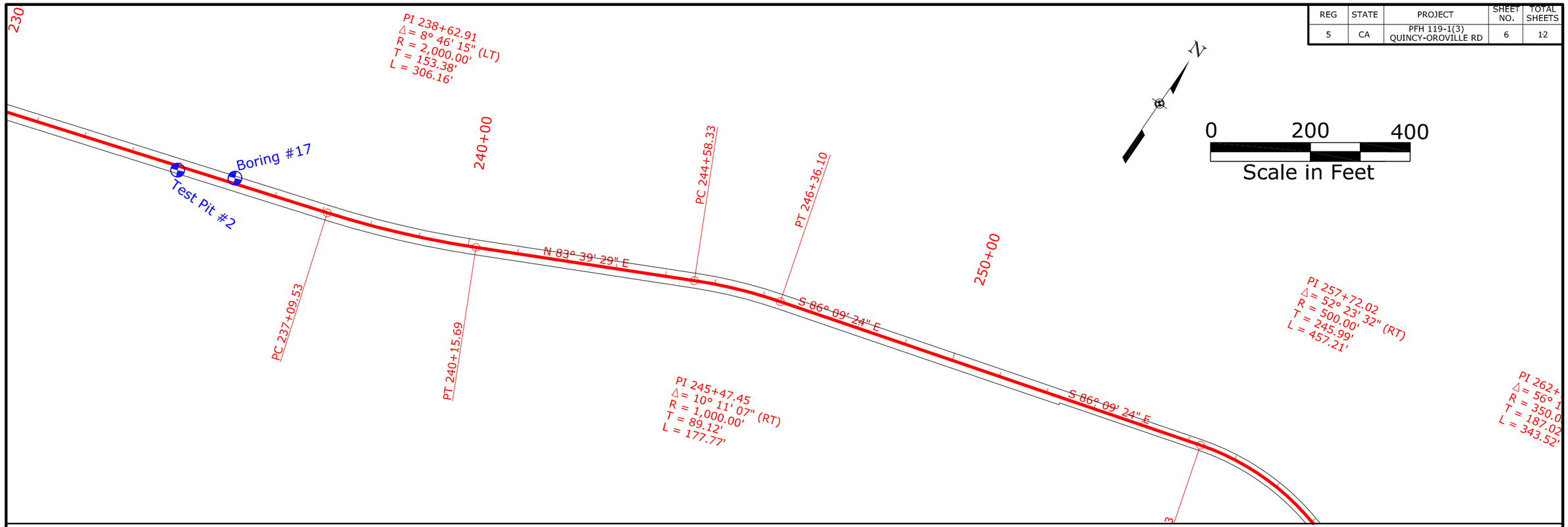
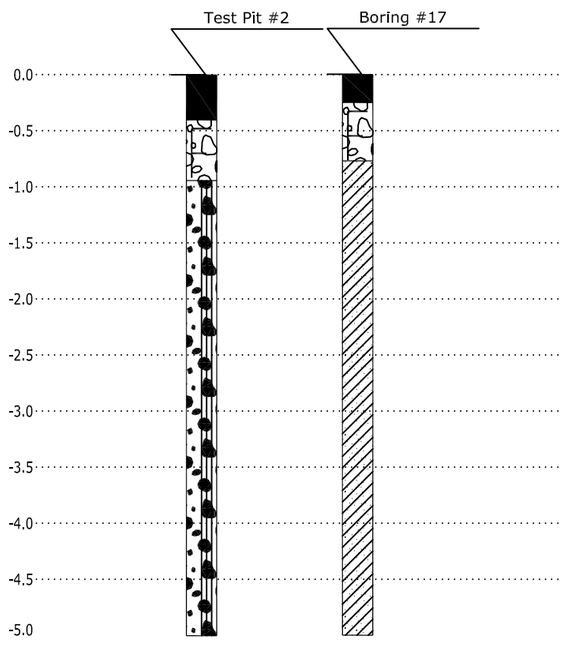




SUMMARY OF TEST RESULTS

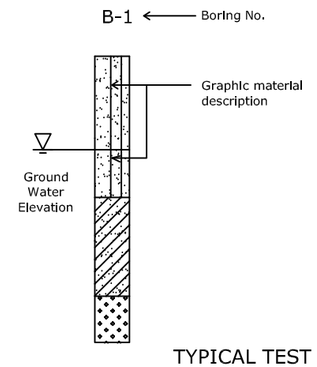
Boring No.	Depth (ft)	Sample Type	Natural Moisture %	Sieve Analysis AASHTO Gravel >#4	Sand	Fine<#200	Atterberg Limits Liquid Limit	Plastic Limit	Plastic Index	pH	Soil Resistivity (ohm-cm)	Water Soluble Sulfate (%)	R-Value	USCS Classification	AASHTO Classification
Test Pit 2	5	Bulk	3.5	46	44	10	NV	NP	NP	-	-	-	-	GW-GM	A-1-a (0)
Boring 17	5	Bulk	7.9	19	35	46	31	22	9	-	-	-	-	SC	A-4 (1)

LEGEND

Soil Lithology

- Asphalt
- Base Course
- USCS Clayey Sand
- USCS Well-graded Gravel with Silt

TYPICAL TEST HOLE LOG



TYPICAL TEST HOLE SYMBOL

Plan View

Location of any test hole

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Consulting Geotechnical Engineers
5700 E. Evans Ave. Denver, CO 80222
Phone: (303)781-9590 Fax: (303) 781-9583

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Engineering Geology Sheet STA. 230+50 to STA. 258+00

STANDARD APPROVED FOR USE XX/XX

REVISED: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

STANDARD

APPENDIX E
Traffic Loading Calculations

Appendix E

TRAFFIC LOADING
ESAL Calculations for Quincy to Oroville Road (25-193)

Begin Project to Haskins Tee (Sta 253+00)

Given:

ADT	2010 Daily Volume =	700	% Trucks	13	
ADT	2030 Daily Volume =	1140	% Trucks	13	

Assumptions:

Truck Split

	12%	Logging Trucks =	2.2	ESALs/Truck
	1%	2-3 axle Single Units =	1.5	ESALs/Truck
	0	2 Axle Recreational Vehicles =	0.5	ESALs/Truck
Total =	13%	Trucks		

Passenger Factor = 0.0004 ESAL/Car

Using the CDOT Averaging Method, the average of the Construction Year Volume and the project Design Year Volume yields the following:

2010 Daily Volume =	700	ADT
2030 DailyVolume =	1140	ADT

Average Design daily Volume = 920

Coupling this design Volume with the ESAL Factors for trucks and cars yields:

Logging Trucks = 2.2 ESAL/veh X 12% X 920 X 365 days/year X 20 years =	1773024
2-3 Axle Trucks = 1.5 ESAL/veh X 1% X 920 X 365 days/year X 20 years =	100740
2 Axle Rec Veh. = 0.5 ESAL/veh X 0% X 4782.5 X 365 days/year X 20 years =	0
PU & Cars = 0.0004 ESAL/veh X 87% X 4782.5 X 365 days/year X 20 years =	2337.168
Total 20-Year ESALs =	1876101.2
Directional Split Factor = 0.6 for two lane road = 1876101 X 0.6 =	1125660.7
20-Year Design ESALs USE	**1,125,661**

Haskins Tee (Sta 253+00) to East End of Project (Sta 669+61)

Given:

ADT	2010 Daily Volume =	500	% Trucks	19
ADT	2030 Daily Volume =	820	% Trucks	19

Assumptions:

Truck Split

	18%	Logging Trucks =	2.2	ESALs/Truck
	1%	2-3 axle Single Units =	1.5	ESALs/Truck
	0	2 Axle Recreational Vehicles =	0.5	ESALs/Truck
Total =	19%	Trucks		

Passenger Factor = 0.0004 ESAL/Car

Using the CDOT Averaging Method, the average of the Construction Year Volume and the project Design Year Volume yields the following:

2010 Daily Volume =	500	ADT
2030 DailyVolume =	840	ADT

Average Design daily Volume = 670

Coupling this design Volume with the ESAL Factors for trucks and cars yields:

Logging Trucks = 2.2 ESAL/veh X 18% X 670 X 365 days/year X 20 years =	1936836
2-3 Axle Trucks = 1.5 ESAL/veh X 1% X 670 X 365 days/year X 20 years =	73365
2 Axle Rec Veh. = 0.5 ESAL/veh X 0% X 670 X 365 days/year X 20 years =	0
PU & Cars = 0.0004 ESAL/veh X 81% X 670 X 365 days/year X 20 years =	1702.068
Total 20-Year ESALs =	2011903.1

Directional Split Factor = 0.6 for two lane road =

2011903 X 0.6 = 1207141.8

20-Year Design ESALs USE 1,207,142

Future Design Traffic Volume Determination

2004	600		2004	430	
2005	615		2005	441	
2006	630		2006	452	
2007	646		2007	463	
2008	662		2008	475	
2009	679		2009	487	
2010	696	Use 700	2010	499	Use 500
2011	713		2011	511	
2012	731		2012	524	
2013	749		2013	537	
2014	768		2014	550	
2015	787		2015	564	
2016	807		2016	578	
2017	827		2017	593	
2018	848		2018	608	
2019	869		2019	623	
2020	891		2020	638	
2021	913		2021	654	
2022	936		2022	671	
2023	959		2023	687	
2024	983		2024	705	
2025	1008		2025	722	
2026	1033		2026	740	
2027	1059		2027	759	
2028	1085		2028	778	
2029	1112		2029	797	
2030	1140	Use 1140	2030	817	Use 820

APPENDIX F
Pavement Design Calculations

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Station 0+00 to 253+00 (Haskins Tee)
25-193
R=35
Overlay Section -R = 50

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,125,661
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.24 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC	0.1	1	5	12	0.50
2	Existing HMA	0.26	1	4	12	1.04
3	New HCAP	0.44	1	4	12	1.76
Total	-	-	-	13.00	-	3.30

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Station 253+00 (Haskins Tee) to Station 306+47
(Haskins Tee East for one mile)
25-193
R=35
Overlay Section R=50

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,207,142
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.28 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC	0.1	1	5	12	0.50
2	Old HMA	0.26	1	4	12	1.04
3	New HCAP	0.44	1	4	12	1.76
Total	-	-	-	13.00	-	3.30

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Station 426+70 to 574+70 and 640+17 to 699+61
25-193
Pulverization 6 inch depth

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,207,142
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.28 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC (Existing)	0.1	1	2.5	12	0.25
2	Pulverization	0.12	1	6	12	0.72
3	New HACP (Superpave)	0.44	1	5.5	12	2.42
Total	-	-	-	14.00	-	3.39

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Station 426+79 to 574+70 and 640+17 to 699+61
25-193
Full Depth Reclamation 6 inch with Foamed Asphalt

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,207,142
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.28 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC Existing	0.1	1	2.5	12	0.25
2	Full Depth Reclam Foamed AC	0.25	1	6	12	1.50
3	New HCAP (superpave)	0.44	1	3.5	12	1.54
Total	-	-	-	12.00	-	3.29

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Station 426+79 to 574+70 and 640+17 to 699+61
25-193
Full Depth Reclamation 6 inch with Emulsion

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,207,142
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.28 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC Existing	0.1	1	2.5	12	0.25
2	Full Depth Reclam Emulsion	0.25	1	6	12	1.50
3	New HACP (Superpave)	0.44	1	3.5	12	1.54
Total	-	-	-	12.00	-	3.29

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Station 426+79 to 574+70 and 640+17 to 699+61
25-193
Full Depth Reclamation 6 inch with Cement

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,207,142
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.28 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC (Existing)	0.1	1	2.5	12	0.25
2	FDR with Cement	0.18	1	6	12	1.08
3	New HCAP (Superpave)	0.44	1	4.5	12	1.98
Total	-	-	-	13.00	-	3.31

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Station 426+79 to 574+70 and 640+17 to 699+61
25-193
Cold Recycle and Overlay

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,207,142
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	8,065 psi
Stage Construction	1
Calculated Design Structural Number	3.28 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC	0.1	1	5.5	12	0.55
2	Cold Recycled Mat	0.28	1	3.5	12	0.98
3	New HACP (Superpave)	0.44	1	4	12	1.76
Total	-	-	-	13.00	-	3.29

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

Quincy to Oroville Highway
Grizzly Creek Bridge Approach
25-193
R=50
Imported fill R >/= 50

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,125,661
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	80 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	13,168 psi
Stage Construction	1
Calculated Design Structural Number	2.68 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	ABC Class 6 (R > 60)	0.1	1	6	12	0.60
2	New HACP	0.44	1	5	12	2.20
Total	-	-	-	11.00	-	2.80

APPENDIX G
Treatment Options and Costs

Appendix G
Treatment Options and Costs

Quincy - Oroville Road, California 25-193

					HMA Thickness	Tons/yd2	$/yd2
Given:	HMA =	$100.00	/ton	=>	2	0.11	$11.00
	Pulverization=$.45/ft2	$4.00	/yd2		2.5	0.1375	$13.75
	Reclamation=$.45/ft2	$4.00	/yd2		3	0.165	$16.50
	Cold Recycle =	$5.00	/yd2	Emul. Included	3.5	0.1925	$19.25
	Asphalt Cement =	$400.00	/ton		4	0.22	$22.00
	Emulsified Asphalt =	$450.00	/ton		4.5	0.2475	$24.75
	Cement =	$150.00	/ton		5.5	0.3025	$30.25
	Fly Ash =	$130.00	/ton				
	Existing Base and HMA = 145#/ft3						
	HMA = 110 #/yd2-inch						

6 Inch Base Treatment Cost

Asphalt C	@ 3% =	$3.92	/yd2
Emulsion	@ 3% =	$4.40	/yd2
Cement	@ 3% =	$1.47	/yd2
Cement	@ 1% =	$0.49	/yd2

Individual Treatment Costs

		HMA	Base Treatment	Additive	Total Cost /yd2	24-foot Cost/Mile 14080 yd2
Overlay Existing	SLC=0.26					
Thickness		4.0	None			
Cost/yd2		$22.00			$22.00	$309,760.00
Cold Recycle - 3.5"	SLC=0.28					
Thickness		4.0				
Cost/yd2		$22.00	$5.00		$27.00	$380,160.00
Pulverization - 6"	SLC=0.12					
Thickness		5.5				
Cost/yd2		$30.25	$4.00		$34.25	$482,240.00

Full Depth Reclamation Options

Foamed Asphalt - 6"	SLC=0.25			3% AC + 1%		
Thickness		4.0		Cement		
Cost/yd2		$22.00	$4.00	$4.31	$30.31	$426,764.80
		plus 1% Cement				
Emulsified Asphalt - 6"	SLC=0.25					
Thickness		4.0		3% Emulsion		
Cost/yd2		$22.00	$4.00	$4.40	$30.40	$428,032.00
Cement - 6'	SLC=0.18					
Thickness		4.5		3% Cement		
Cost/yd2		$24.75	$4.00	$1.17	$29.92	$421,273.60

SLC= Structural Layer Coefficient